Compressed Air Magazine

JUNE 1955

PHOTOGRAPH BY JOSEPH E. VAUEL

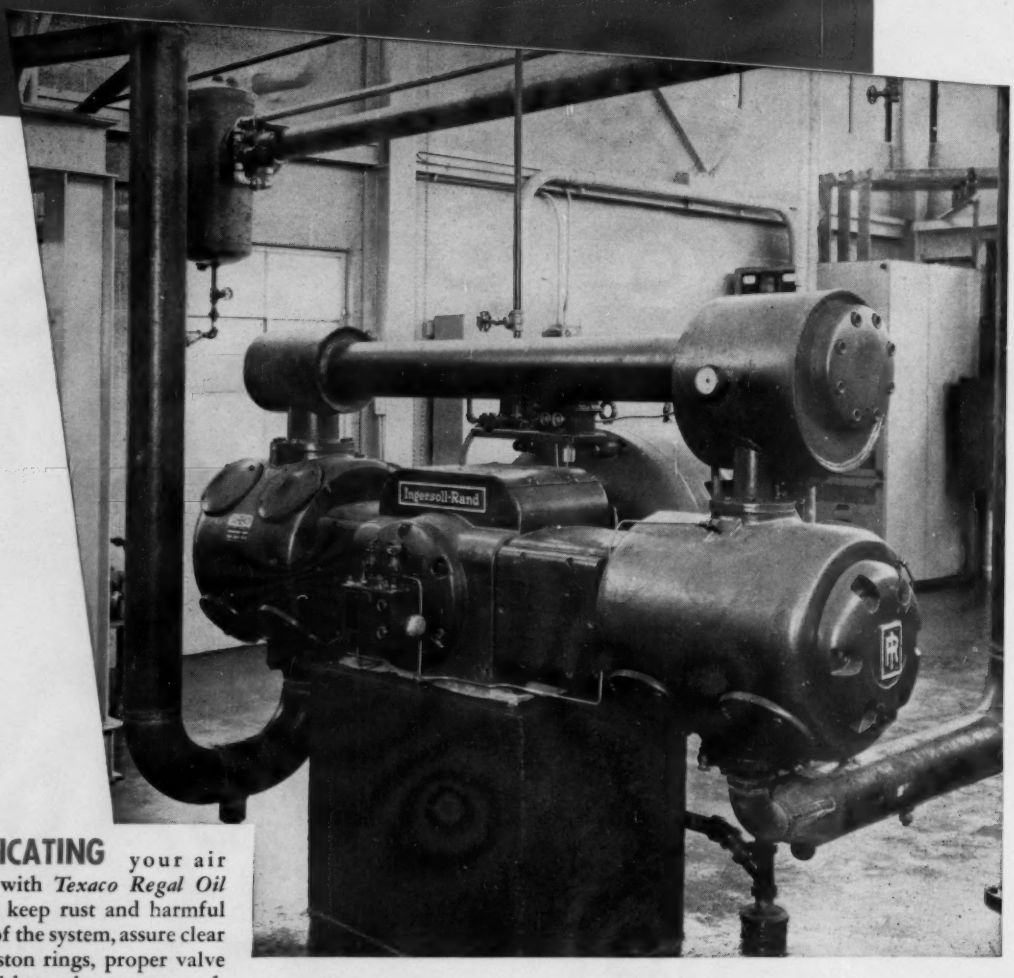
COMPRESSED AIR FOR A MERMAID

How enables performer in Florida underwater show to submerge half hour

VOLUME 60 • NUMBER 6

NEW YORK • LONDON

CLEANER SYSTEMS ...LOWER COSTS



BY LUBRICATING your air compressors with *Texaco Regal Oil R&O,* you'll keep rust and harmful deposits out of the system, assure clear lines, free piston rings, proper valve action. You'll have cleaner, more efficient operation...reduce your maintenance costs.

Texaco Regal Oil R&O is premium quality—especially refined from selected base stocks, then *further improved* by effective additives and extra processing.

There is a complete line of *Texaco Regal Oils R&O.* You can get one exactly right for any compressor, whatever its size or type, whatever the number of stages or the pressure, whatever the operating conditions.

Let a Texaco Lubrication Engineer help you make the proper selection. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Regal Oils R&O

FOR ALL AIR COMPRESSORS AND OPERATING CONDITIONS

TUNE IN... TEXACO STAR THEATER starring JIMMY DURANTE or DONALD O'CONNOR on television... Saturday nights, NBC.

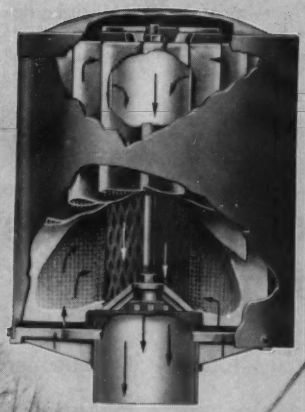
Circle 1A on reply card *Circle 2A on reply card*

STAYNEW

INTAKE FILTERS ASSURE ABRASIVE-FREE AIR

for the Ingersoll-Rand QUARRYMASTER*

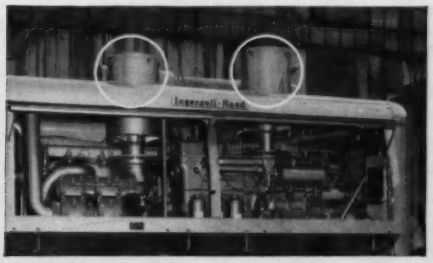
Staynew Intake Filters, standard equipment on every Ingersoll-Rand Quarrymaster, protect engines, compressors and cylinders from the abrasive material in intake air.



Staynew Filter's "positive protection" minimizes wear, keeps equipment at top efficiency longer. They are efficient over a wide range of loads and not affected by temperature changes. Dry-type filtering media removes dust particles without viscous or oily filter aids. There's no oil carry-over . . . no need for carefully held maintenance schedules. Staynew Intake Filters are easy to clean on the job.

When your air compressing equipment demands the protection Staynew Intake Filters are designed to give, specify . . . and get . . . Staynew.

CLOSE-UP of two of the four Staynew Model D Intake Filters at work protecting air intakes on an Ingersoll-Rand Quarrymaster.



*The Ingersoll-Rand Quarrymaster is a self-contained primary blast hole rig complete with drill, power plant, propulsion elements and auxiliary equipment, all mounted on tractor treads. Operating in quarries and large construction jobs in extremely dusty locations—clean intake air is a must for the diesel engine, compressor and various air motors comprising the unit. A continuous supply of abrasive-free intake air is assured by four Staynew Model D Intake Filters on every Quarrymaster.

Representatives In Principal Cities

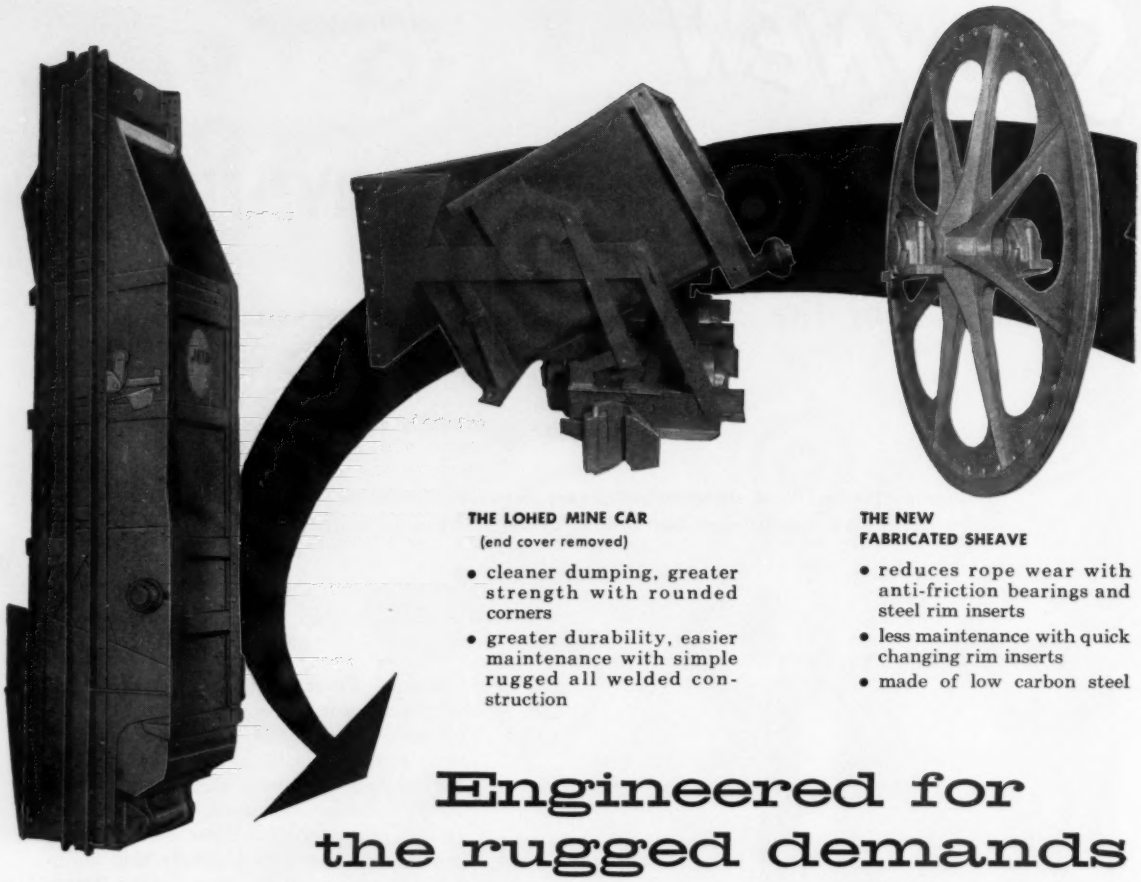
DOLLINGER PROTECTED BY STAYNEW FILTERS

DOLLINGER

CORPORATION

7 Centre Park Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



THE LOHED MINE CAR
(end cover removed)

- cleaner dumping, greater strength with rounded corners
- greater durability, easier maintenance with simple rugged all welded construction

THE NEW FABRICATED SHEAVE

- reduces rope wear with anti-friction bearings and steel rim inserts
- less maintenance with quick changing rim inserts
- made of low carbon steel

THE "JETO" BOTTOM DUMP SKIP

- less dead load, greater pay load with light-weight aluminum and steel construction
- increased production with cleaner faster dumping action
- Lighter less expensive headframe construction due to greatly reduced headframe travel
- greater safety with positive dumping action and body safety latch

Engineered for the rugged demands of metal mining!

For close to 100 years Lake Shore has focused its seasoned engineering attention on developing equipment to make metal mining operations more efficient and safer. Excellent results of that continuous effort are the "Jeto" bottom dump skip, the new fabricated sheave, and the all welded "Lohed" mine car; useful developments that have achieved increased production, lower maintenance costs, and longer equipment life for the metal mining industry. Write for detailed product bulletins.

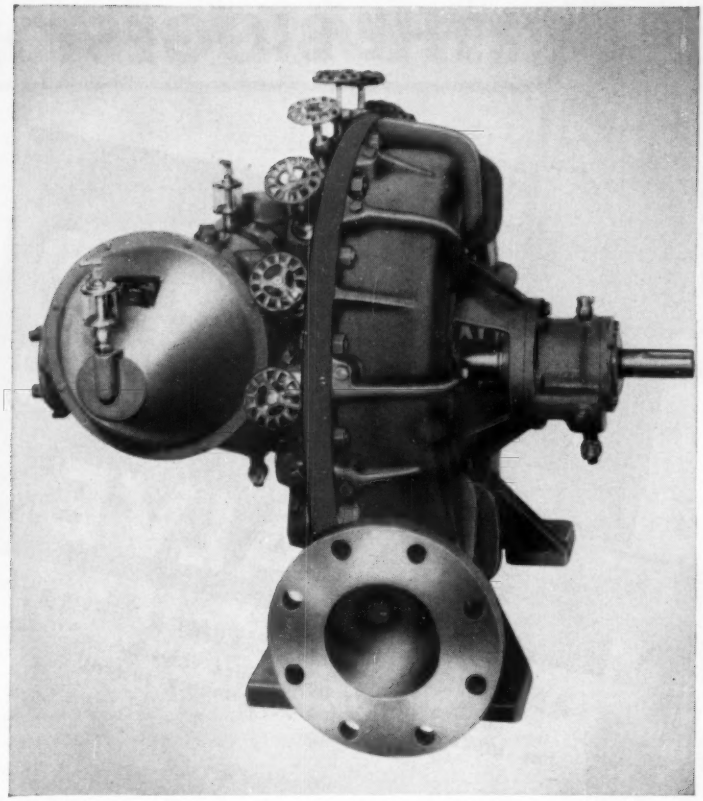
LAKE SHORE
Engineering Company

Iron Mountain 5, Mich.
Plants: Iron Mountain and Marquette, Michigan

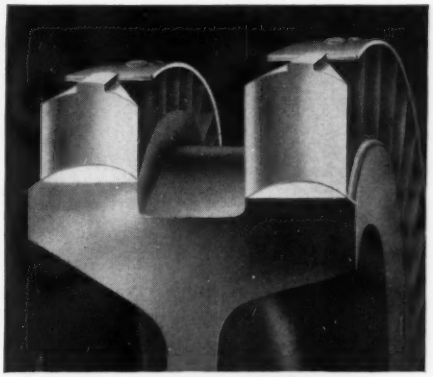
Branch Offices: Denver • Chicago • New York • Detroit • Phoenix San Francisco • Milwaukee and Ishpeming

Underground cars • skips • cages • trestle cars • sheaves grizzlies • snatch blocks • hoists • mills • special equipment

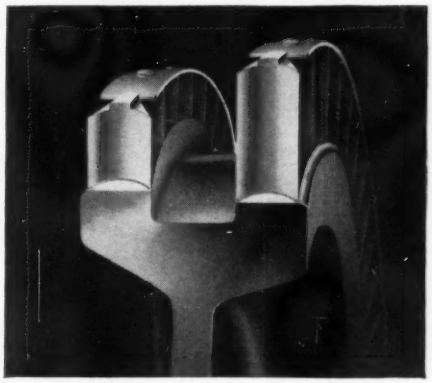
Circle 3A on reply card



This is the reliable Coppus Turbine furnished with either type of wheel



Wide bucket "L" type wheel



Regular type wheel

Top performance in all COPPUS TURBINES

Both the regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. The "L" type wheel is the new development for use where low water rate is essential.

Coppus "Blue Ribbon Turbines" earned their fine reputation right on the job. Users vouch for their top quality performance and their low maintenance cost.

In the words of the supervisor of a large chemical company: "Coppus turbines require so little maintenance that a person would starve to death, if he depended on it for a living."

Proven features of *all* Coppus Turbines:

- Turbines rated close to your hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbines.

COPPUS ENGINEERING CORPORATION
206 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

Circle 4A on reply card

THE BIGGEST

Announcing

THE LQ600 VALVE

ANOTHER LUNKENHEIMER "FIRST"
. . . the revolutionary new bronze valve which has broken all existing performance records!

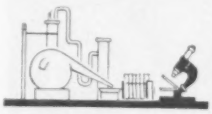
LUNKENHEIMER THANKS ALL OF THE LEADING COMPANIES WHO COOPERATED IN THE FOUR-YEAR LQ600 FIELD TESTING PROGRAM

The LQ600 Valve has been tested for four years in carefully chosen "problem installations" in American industry. *Despite the poor records of previous valves, there was not one single reported case of failure or leakage of an LQ600 Valve!* Here are a few typical records:

LUNKEN

THE ONE *Great*

RONZE VALVE NEWS IN 50 YEARS!



This revolutionary bronze globe valve has set completely new performance standards in the most severe service in industry!

LQ600 gives you so much *more* service per dollar that you can't afford to continue using bronze globe valves that require constant repair and replacement!

Valve users, cooperating in a four-year testing program, were unable to find *any* service tough enough to wear out an LQ600 — or cause it to leak, even in the most severe throttling installations! This new valve is an investment — one that pays cash dividends in maintenance savings year after year!

BRINALLOY* SEATS AND DISCS make these remarkable performance records possible. This exclusive new Lunkenheimer alloy is far more resistant to wear and corrosion than 500 Brinell Stainless Steel — even outwears case hardened Stainless Steel exceeding 1000 Brinell! There is no need for renewability. *No LQ600 Valve in four years service has required maintenance.*

OTHER FEATURES — a streamlined new exterior . . . the famous Stemalloy® Stem, which far outlasts any other stem material . . . the cool, easy-to-grip Non-Slip® patented handwheel . . . durable, high-strength bronze in body and bonnet . . . and true back-seating, permitting safe and easy repacking under pressure.

*Patented alloy. Trade Mark, The Lunkenheimer Co.

For more information, call your local Lunkenheimer Distributor or write The Lunkenheimer Company, Box 360, Cincinnati 14, Ohio.

TYPE OF SERVICE	LIFE OF OTHER VALVES	USER COMMENT
125 lb. hose steaming	2 wks. to 2 mos.	Toughest service, previous valves leaked.
Water col. blowdown	2 mos.	Plug valves couldn't take it.
185 lb. steam blowdown	1 yr.	Plug valves failed every year.
125 lb. steam blowdown	"Short"	Previous valve leaked every run.
200 lb. steam—water col. blowdown	2 mos.	Previous valves failed by wiredrawing.
Throttling syrup 140°F.	"Short"	Previous valves cut.
150 lb. throttling 380°F.	6 mos.	Plug valves failed regularly.
100 lb. throttling	2 wks. to several mos.	Plug valves couldn't hold up.
130 lb. throttling	8 mos.	Composition seat valves unsatisfactory.
110 lb. throttling steam	3 wks. to 3 mos.	Three other kinds failed.
Scaled hot water line	"Short"	About all makes used—none held up.
125 lb. throttling steam	6 to 12 mos.	Plug valves failed by wiredrawing.
150 lb. steam—scale present	"Short"	Previous valves broke.
150 lb. throttling steam	4 to 5 mos.	Other makes failed by wiredrawing.

LQ600
150 LB. S.P.
300 LB. W.O.G.

HEIMER®

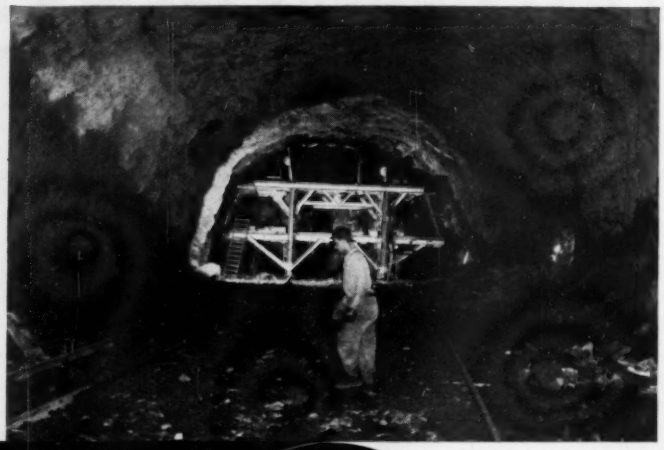
BRONZE • IRON
STEEL • PVC

NAME IN VALVES

L-455-4

Circle 5A on reply card

Part way through the 705 foot rock section on the New Jersey side.



THEY'RE AVERAGING 630-FEET PER ROD

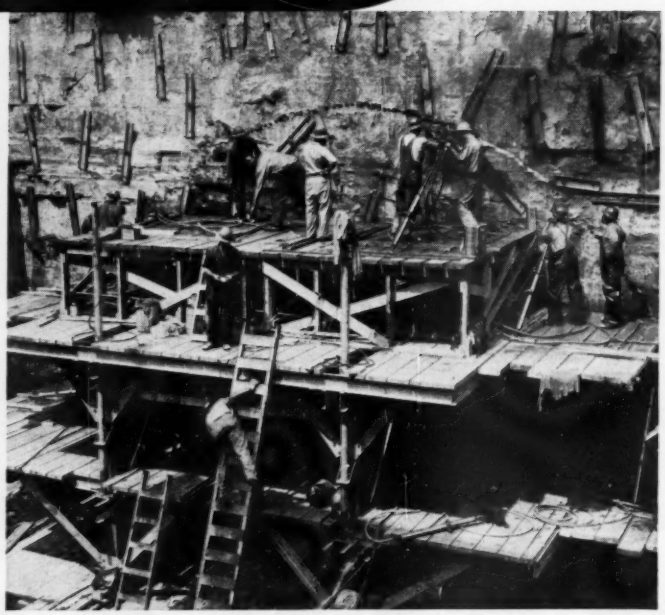
with

CRUCIBLE alloy hollow drill steel...

When completed the third tube of the Lincoln Tunnel will speed vehicular traffic between New York and New Jersey under the Hudson River.

On the New Jersey side construction involves tunneling through 705 feet of rock, and moving 24,000 cubic yards of trap-rock and sandstone. For this big job the contractors, Mason Johnson MacLean, chose Crucible CA Double Diamond alloy hollow drill rods. It proved to be an excellent choice, for in drilling 108,500 feet of hole, Crucible alloy drill rods gave an average of *630-feet per rod.*

There's good reason for this *extra* performance. For Crucible alloy hollow drill rods are made to *tool steel standards,* by the nation's leading producer of tool and other special purpose steels. You can count on longer rod life . . . fewer broken rods . . . *lowest cost per foot of hole drilled* . . . when you specify Crucible alloy hollow drill rods. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*



Drilling starts on the third tube of the Lincoln Tunnel.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Circle 6A on reply card

BIG BROTHER TO A DENTAL DRILL

"Painless," efficient drilling of primary blast holes in the earth's rock crust—by either percussion or rotary action—is a cinch for Ingersoll-Rand's heavy-duty Quarrymaster. But its greatest advantage lies in the built-in hole cleaner, made possible by using B&W Mechanical Tubing for the drill rod. An automatic, continuous stream of compressed air is forced down through the tubular drill rod to the bit and back up, between drill rod and casing, to the surface, carrying the cuttings with it. And this hollow drill rod has been proved stronger, lighter and more rigid than a solid bar.

To satisfy vital requirements such as long life under extreme conditions of impact, B&W imparted desirable cold-worked properties to this tubing and also devised a special hot-upsetting procedure. With Quarrymasters now in service all over the world, the effectiveness of their drill rods made of B&W Mechanical Tubing has long since been decisively demonstrated.

For a comprehensive story of how B&W Mechanical Tubing serves many industries, ask for Technical Bulletin 361 000

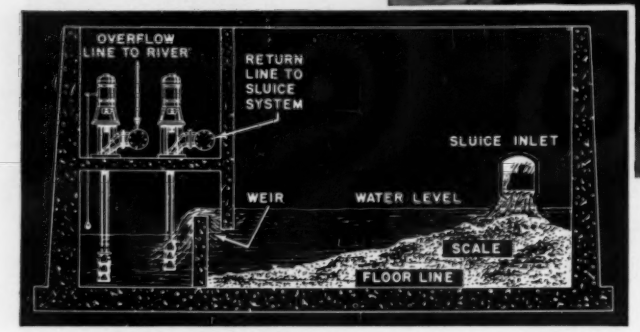
B&W
TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis.: Seamless Welding Fittings

TA-5005(M)

Circle 7A on reply card

Pumping Pit with Ingersoll-Rand vertical turbine pumps, heart of mill-scale recovery system at Allenport, Pa. plant of Pittsburgh Steel Corp. Two 6000 gpm units, in foreground, recirculate settled water. Smaller 3000 gpm pumps, at top, discharge overflow into river.



In Rolling Slabs at the hot strip mill, scale is removed from hot steel by water jets. Water carries the scale into a collecting tank. From the tank, a clam-shell bucket removes it to sintering plant. Steel content is used in blast furnaces, and stream pollution is reduced by the mill-scale recovery.

In mill-scale recovery

I-R Pumps of Stainless give 30 Times the Life

CORROSIVE ACTION of a notoriously unclean river . . . polluted with acid mine drainage . . . is defeated by these Ingersoll-Rand pumps.

Erosion is minimized, too. Erosion by abrasives in recirculated water of a millscale sluicing system. And erosion by hard, tough particles in water agitated by a clamshell used for scale removal.

That's why pumps of standard materials needed extensive repairs after only two months' use.

In contrast, chromium-nickel stainless steel units operated five years without replacements or loss in efficiency and performance.

Ingersoll-Rand pump specialists, metallurgists and engineers use these money-saving nickel alloys for impellers, casings, shafting, bolting and even for small interior parts of pumps in mill-scale service.

You, too, may set new standards of low-cost performance. Redesign to increase strength, yet reduce size and weight of your products or equipment, by using nickel alloys.

When you have a metal problem, let us help you. We'll give you suggestions based on wide practical experience. Take the first step now . . . write for "List A" of our available publications. With it comes a form for outlining your difficulties. Write today.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

Circle 8A on reply card

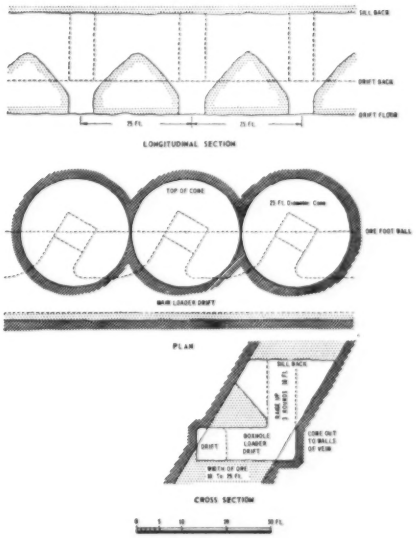
INCREASE PRODUCTION LOWER COSTS

Yes! You can increase production and lower costs by using Eimco loaders to load your production tonnage.

The advantages of being able to load larger pieces, use less powder, practically eliminate secondary blasting and absolutely eliminate expensive chutes and grizzlies, will enable your mine to get into production in a new area faster at less expense.

That's why so many mining men are traveling to see mines that have changed their systems to production loading with Eimcos.

Many different ideas for saving time and lowering costs have been developed by operators to fit their particular conditions. A sketch of one of these is at right. Eimco engineers have helped work out numerous systems, they will be glad to help you. Write Eimco for information.



THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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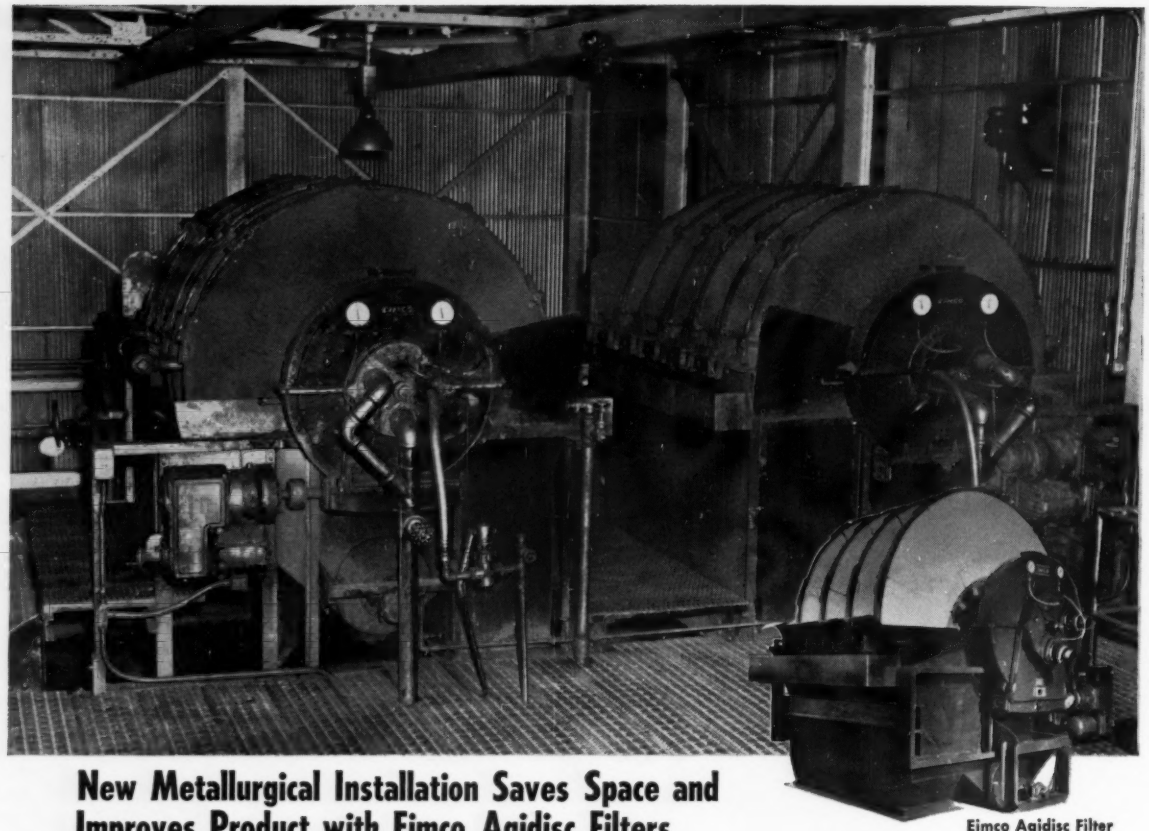
You Can't Beat An Eimco

874



Eimco Agidisc Filter

New Metallurgical Installation Saves Space and Improves Product with Eimco Agidisc Filters

The photo above shows an installation of two 6' diameter by 5 disc Eimco Agidisc Filters in their operating position in a new metallurgical concentrating plant.

These filters were installed as a result of the owner company and Eimco cooperation in a joint effort to improve the operation of the filter station at this plant and reduce moistures with the most economical equipment.

After the installation had been operating for six months the following data was made available.

		PREVIOUS EQUIPMENT	NEW EIMCO FILTERS
1.	Concentrate handled	350,000 lbs./24 hrs.	350,000 lbs./24 hrs.
2.	Labor required	1 man full time	1 man part time
3.	Attention required	Constant inspection	Periodical inspection every 6-8 hrs.
4.	Operating Capacity	Full load—no capacity for additional tonnage	½-¾ load—capacity for 33% to 100% additional tonnage
5.	Equipment	4—Drum filters (not Eimco)	2—6' dia. x 5 disc Eimco Agidiscs
6.	Filter area	621 sq. ft.	500 sq. ft.
7.	Floor Space occupied	416 sq. ft. filters only	189 sq. ft. filters only
8.	Cake Moisture	20%—21%	14%—15%
9.	% Moisture reduction over previous method		33%
10.	Filter rate increase over previous method		more than 15%

Eimco specializes in equipment to do a better job in filtration. Before you buy, take advantage of Eimco's experience in building filtration equipment for customers who look beyond first cost to get quality construction, individual design and guaranteed performance.

EIMCO

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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B-102

PAN

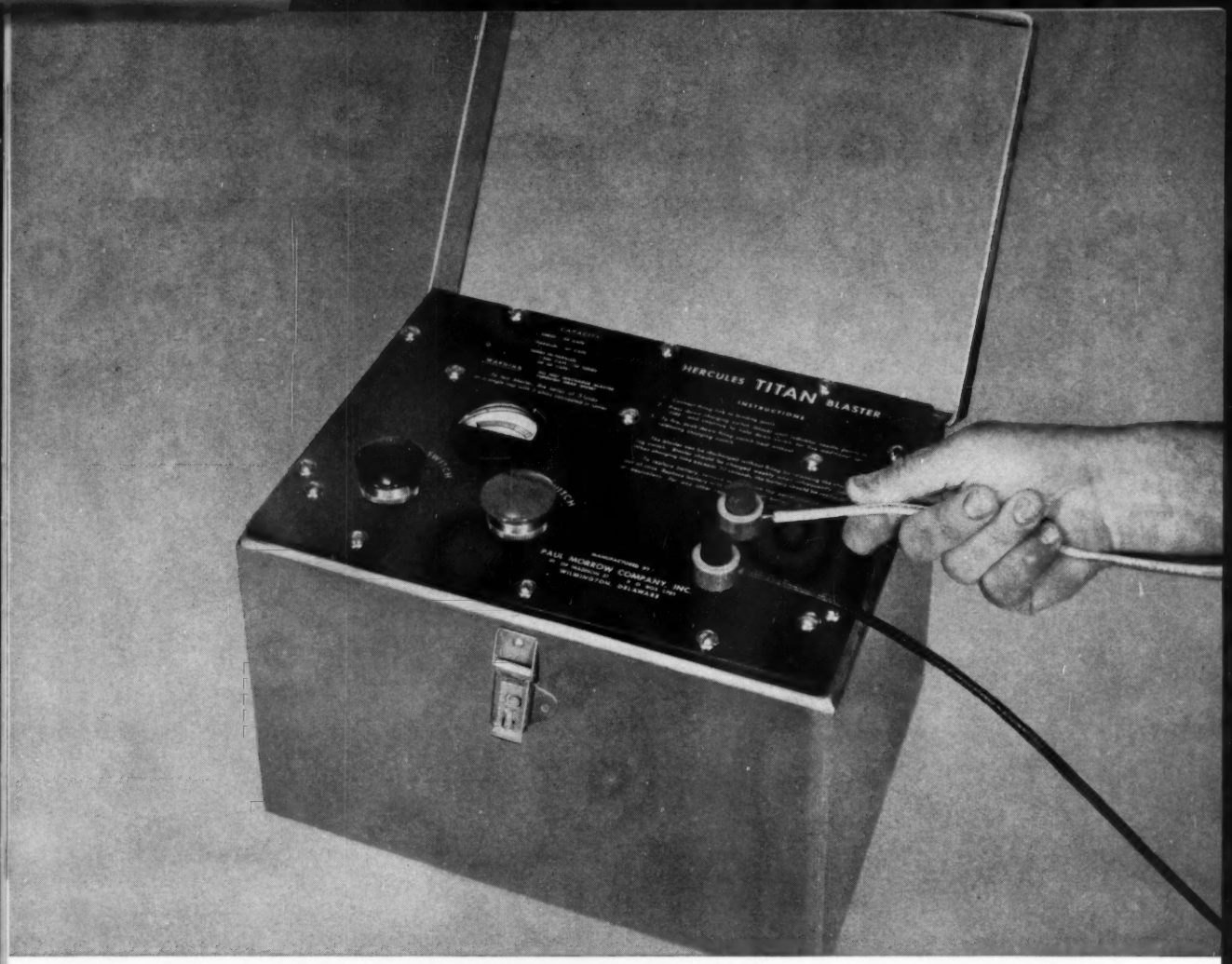
CONTINUOUS PRESSURE

PRESSURE PRECOAT

BI-CARB

PRESSURE ROLL

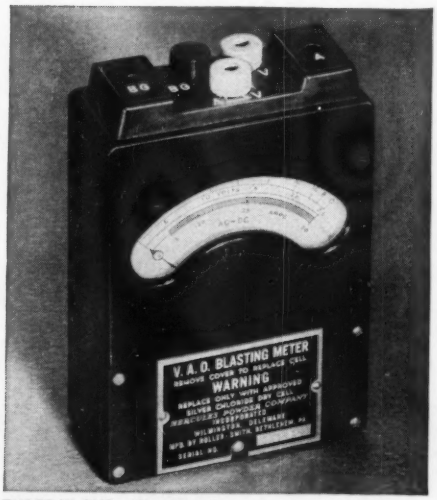
BURWELL



HIGH CAPACITY, YET PORTABLE—The Titan Blaster is housed in a rugged aluminum case and is waterproof.

NEW HERCULES TITAN BLASTER

For Maximum Safety, Economy



THREE-IN-ONE—The V.A.O. meter, available through Hercules, is a combination voltmeter, ammeter, and blasting galvanometer that has proved its value in field use as an important blasting aid.

The Hercules Titan® Blaster is a high-capacity, condenser discharge type of blaster that combines maximum safety with minimum maintenance expense.

The Titan Blaster has no moving parts. It is operated by depressing two push-button switches—one to charge and one to fire. This new Hercules blaster develops sufficient electrical energy to fire as many as 1,200 detonators. Yet, there is no high voltage associated with the Titan Blaster except during charge and firing. The source of energy is a relatively inexpensive 6 volt, dry cell ignition-type battery.

For full technical details on the Titan Blaster, write:

HERCULES POWDER COMPANY
INCORPORATED
Explosives Department, 932 King St., Wilmington 99, Del.

XR55-7

IN CALIFORNIA . . . AND THE WORLD OVER

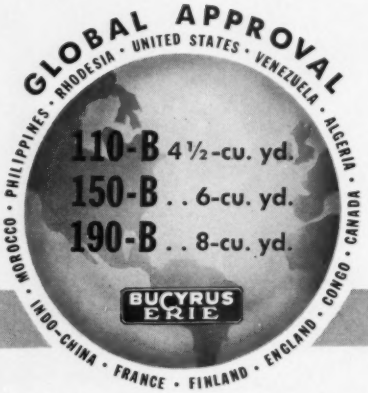
In this quarry at Colton, the powerful 150-B shovel with its 6-cu. yd. dipper has no difficulty in breaking through tough limestone.

Rock meets its master

WITH A BUCYRUS-ERIE SHOVEL ON THE JOB

In a California quarry, this Bucyrus-Erie 150-B shovel is digging and loading hard limestone, delivering outstanding output. This performance story is being repeated daily in quarries, mines and on heavy-duty construction projects throughout the world.

New front-end design, extra-strong construction, and advanced engineering of Bucyrus-Erie Ward Leonard electric excavators give owners that extra margin of output that pays off in profits. 26L54


GLOBAL APPROVAL
UNITED STATES · VENEZUELA · ALGERIA · CANADA · CONGO · ENGLAND · FINLAND · FRANCE · INDO-CHINA · MOROCCO · PHILIPPINES · RHODESIA
110-B 4½-cu. yd.
150-B . . 6-cu. yd.
190-B . . 8-cu. yd.
BUCYRUS ERIE

Bucyrus-Erie Company

South Milwaukee, Wisconsin

Circle 9A on reply card

Rugged Work and a hose to match!

U. S. 4810 Air Hose

Jagged rocks, grinding gravel, severe cold and sun checking, punishing impacts from heavy equipment—all these were faced *and licked* by the "U. S." engineers who designed U. S. 4810. Reason enough why it's become one of the most popular of all hose for mines, quarries, shipyards and general construction work.

Combining super adhesion, great strength, high resistance to cuts and abrasion, and extreme *flexibility,* U. S. 4810 is recommended for all pneumatic tools and air drills, for use *wherever* high working pressures, abrasion, and general abuse pose problems.

Service-packed, economical U. S. 4810 Air Hose is available from any of our 27 District Sales Offices, or by writing to the address below. *Whatever* your hose requirements, you'll find it pays to turn to "U. S." There's a job-engineered U. S. Hose for practically every purpose — an expert staff of "U. S." Engineers to assist you with your hose selection.

- tough, flexible tube of neoprene provides top oil resistance
- high-tenacity, tire-type cable rayon braids give tremendous carcass strength
- thick cover of cut-resistant natural rubber wards off damage from rocks, tools, and equipment

US RUBBER

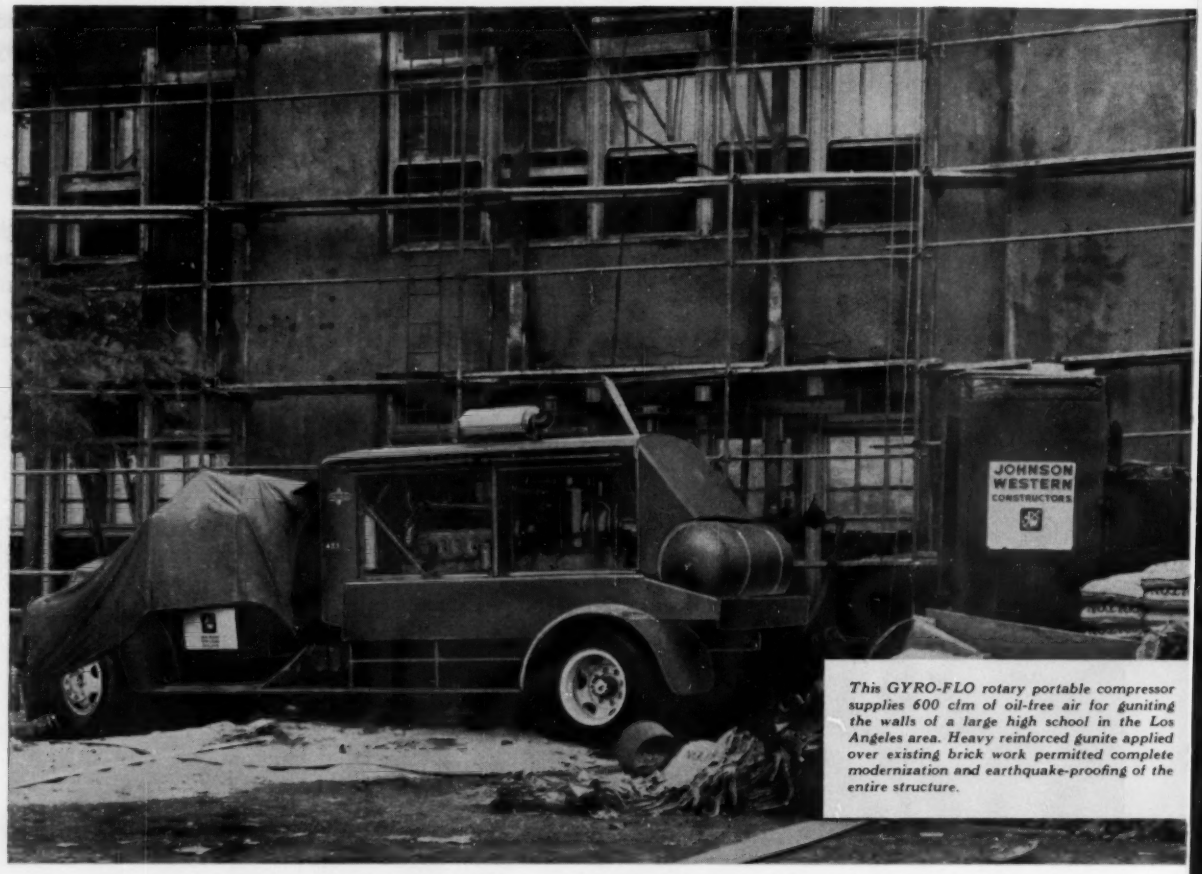
"U.S." Research perfects it..."U.S." Production builds it...U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Circle 10A on reply card



This GYRO-FLO rotary portable compressor supplies 600 cfm of oil-free air for guniting the walls of a large high school in the Los Angeles area. Heavy reinforced gunite applied over existing brick work permitted complete modernization and earthquake-proofing of the entire structure.

Johnson Western Constructors are winning the battle of construction costs with new and improved guniting equipment. Using air power from Ingersoll-Rand GYRO-FLO 600 compressors, these guns are blasting away on a wide range of concrete construction projects.

Extra "fire power" obtained from the 600-cfm GYRO-FLO constitutes a major improvement in the efficiency of the gunite process. The instantly variable regulation of the GYRO-FLO gives the operator constant air pressure, reducing clogging of the hose and "rebound" of sand. Johnson Western engineers estimate that by converting from reciprocating 500-cfm units to GYRO-FLO 600s, they can shoot from 30 to 40 more sacks of cement per day—a gain of 20% in guniting capacity.

There are other advantages, too. One is the compactness and light-weight of the GYRO-FLO unit. It can be mounted on a single truck-trailer body for greater mobility. Another is its exceptional freedom from maintenance. According to Johnson Western, the life expectancy of a GYRO-FLO 600 in guniting work is about 11,000 hours without compressor repairs—equivalent to approximately *four years* of trouble-free service!

Based on this performance, the Gunite Division of Johnson Western is using GYRO-FLO compressors for *all air power requirements*.

Wherever *you* need dependable, low-cost air power, look to GYRO-FLO for important savings in operating and maintenance expense. This advanced-design rotary compressor has no pistons, rings, valves or clutches to wear out or require adjustment—sets new standards of dependable, trouble-free performance. Your nearest Ingersoll-Rand dealer will be glad to give you the complete story.

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GYRO-FLO

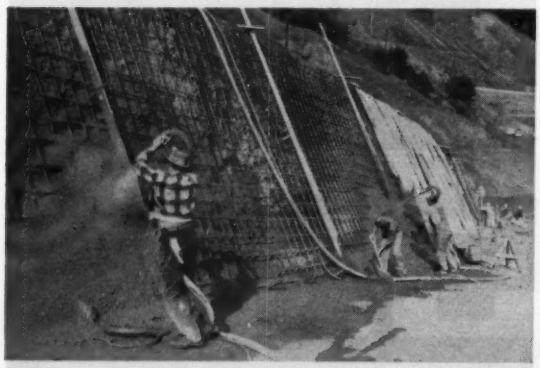
Rotary Compressors

put more "fire power" behind the CEMENT GUNS

Johnson Western Constructors, leading Gunite specialists, upped capacity 20% by switching to 600-cfm GYRO-FLO rotary compressors

Johnson Western finds that swimming pools like this are a natural for the GYRO-FLO gunite team, as the sprayed concrete is highly impervious to moisture and no costly contour forms are required.

GYRO-FLO 600s provide air power for construction of the second barrel of the 60-inch San Diego-San Vicente Aqueduct of Rainbow, California. Here the ready mobility of the truck-mounted compressors was a big asset.



Ten-inch gunite spillway walls for Livingston Dam in Los Angeles, California, are applied directly to the earth banks. Two GYRO-FLO 600s supplied the air power for this big job by Johnson Western Constructors.

St. Luke's Church in Temple City shows how reinforced Gunite powered by GYRO-FLO 600 was used, not only to provide a Class A structure but also to achieve the effect of mission style architecture.

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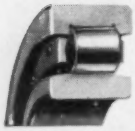

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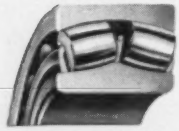
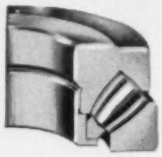


Improved Spherical Roller



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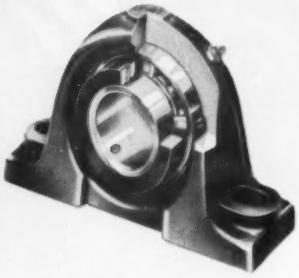

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BEARINGS AND PILLOW BLOCKS

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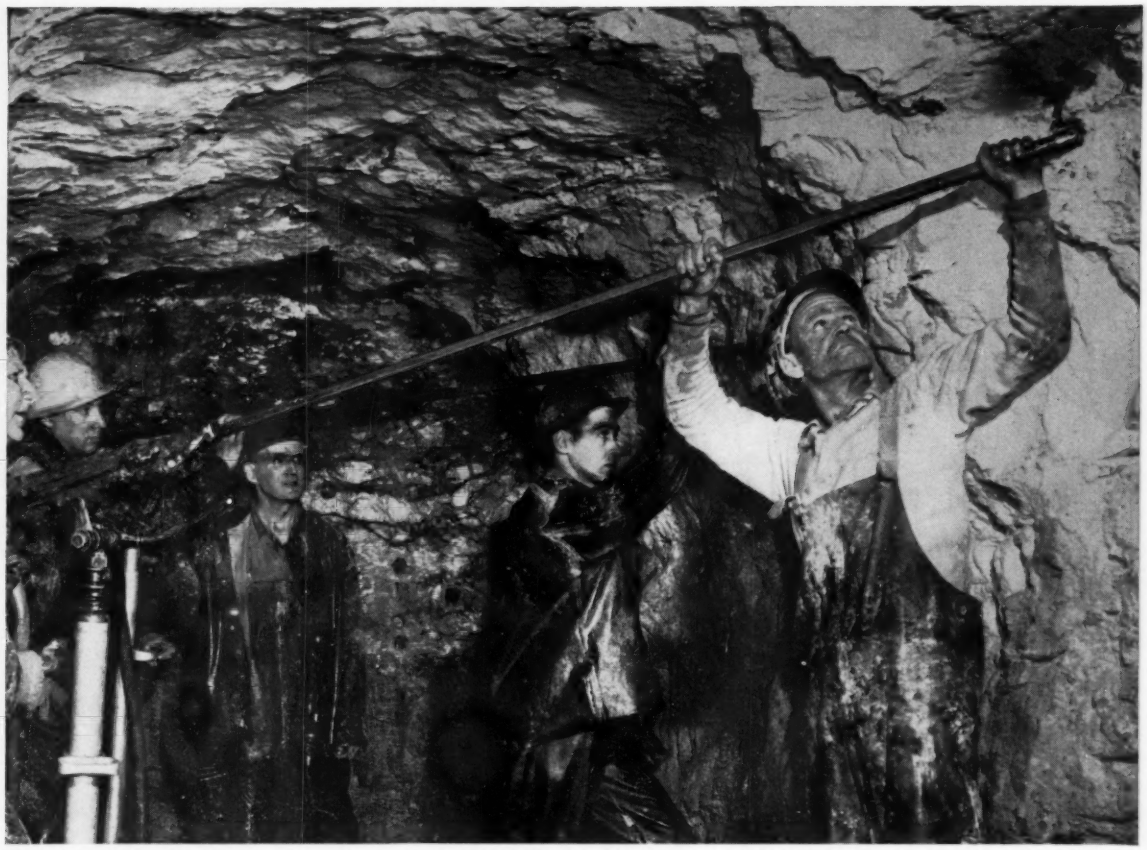
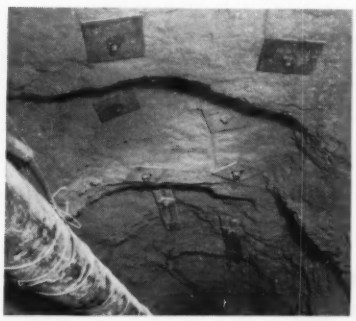


Bethlehem Hollow Drill Steel is giving good service as Tonawanda's water-intake tunnel is bored through solid rock beneath the Niagara River. *General Contractor:* Herbert F. Darling, Williamsville, N. Y.; *Consulting Engineers:* Nussbaumer, Clarke & Velzy, Inc., Buffalo, N. Y.

They're Boring Water-Intake Tunnel Through Rock Beneath Niagara River

The Town of Tonawanda, N. Y., is boring a water-intake tunnel, some 6,000 ft long, about 100 ft beneath the swirling waters of the Niagara River. The tunnel, 7 ft high and 7 ft wide, will be part of Tonawanda's new municipal water system, expected to be in operation late in 1955.



Closeup of Bethlehem roof bolts, used in tunnel with square plates and longitudinal ties to prevent rock falls. These long bolts are driven deep for firm anchorage.

Construction of the tunnel calls for the removal of 9,200 cu yd of rock, most of it medium-hard limestone. Using drills with air-leg mountings, and making exclusive use of 1-in. hexagon Hollow Drill Steel, fitted with carbide bits, the contractors are drilling blast holes 6 ft deep. The total footage drilled is expected to be in the neighborhood of 130,000 lineal ft.

Wherever there's rock to be moved, you can count on satisfactory service from Bethlehem Hollow Drill Steel. This is because Bethlehem Hollow is rolled from a tough, fatigue-resisting steel. It has a wide quenching range. It's easy to heat-treat for the ideal balance of hardness and wear-resistance. It also makes long-wearing threads and tough shanks.

Bethlehem Hollow Drill comes in rounds, hexagons and quarter octagons, usually in lengths of 18 to 25 ft. Longer lengths can be furnished to meet special requirements. It's good, sound drill steel — and it can hold drilling costs to the minimum in any job you name!

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

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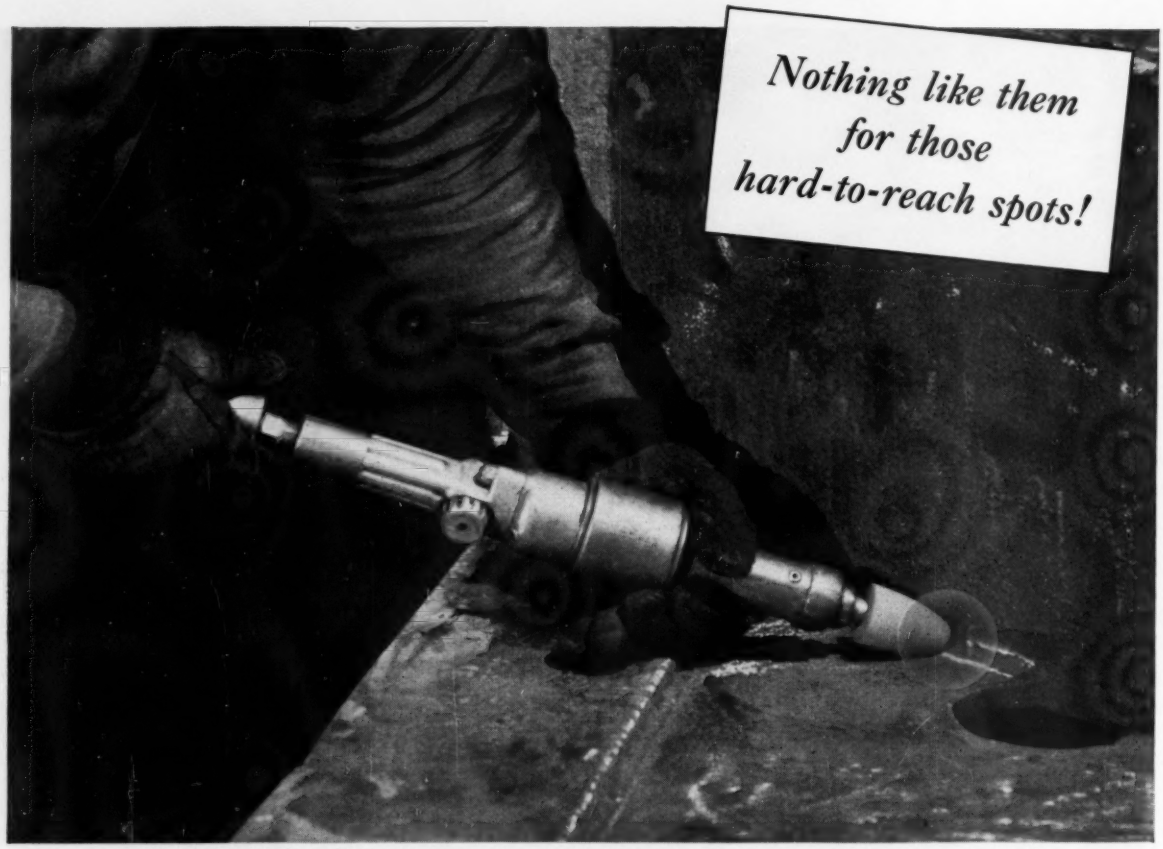
BETHLEHEM STEEL

BETHLEHEM HOLLOW DRILL STEEL



Additional "Touch of Gold" Advantages brought by K Bond CRYSTOLON* cones are freedom from the usual grooving and chipping of vitrified cones on gray and malleable iron applications.

Norton K Bond† Cones

resist grooving and chipping . . . add the saving "TOUCH of GOLD" for snagging gray and malleable iron

The Norton K Bond is the most radically improved vitrified bond ever developed for slow speed snagging of gray and malleable iron.

That's why, every time K Bond CRYSTOLON wheels or cones go to work for you, you can count on these profit-boosting "Touch of Gold" advantages:

1. Faster, freer cutting action
2. Much longer wheel life
3. Less frequent dressing
4. Hold corners better
5. Consistently duplicated

K Bond Cones Stand Up Better

In particular, CRYSTOLON cones made with this outstanding bond overcome the usual tendency of vitrified bond cones to groove excessively and chip off when snagging difficult places on gray or malleable iron castings. On these jobs the following reports are typical of very many received from foundries:

"K Bond cones hold form with no chipping. Best ever used."

"Excellent cutting action. Cones lasted an average of 10 hours — longest service life we ever got."

"These cones last us 50% longer than any others and they're tops for fast cutting."

"For durability and cut, K Bond wheels are far the best we ever tested."

See your Norton Distributor about arranging a test of K Bond CRYSTOLON cones and wheels in your own plant. NORTON COMPANY, Worcester 6, Mass. Distributors in all principal cities, listed under "Grinding Wheels" in your phone directory, yellow pages. *Export:* Norton Behr-Manning Overseas Incorporated, Worcester 6, Mass. W-1624

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NORTON: Abrasives • Grinding Wheels • Grinding Machines • Refractories
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†Patent applied for

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ON THE COVER

THE young lady pictured on the cover is seated 8 feet underwater in a novel theater at Weekieachee Spring, Brooksville, Fla., where the audience views an aquatic pageant through glass walls that are slanted to enable them to peer downward. The girl has a face mask in the hand that is gripping a hose, and she occasionally dons it only to aid her vision, which is otherwise indistinct. She gets her air supply by inserting the hose in her mouth at regular intervals. Some water enters her mouth when she opens it, but the air taken in expels it. She then draws the air into her lungs.

There are several of these performers, and they stay under for half an hour. At times they descend to depths of 70-100 feet, and the pressure of the air is increased correspondingly to overcome the greater water pressure. At one stage in the show, while seated on tree limbs, each drinks a bottle of soda pop and eats a small quantity of food. The girl in our picture is feeding bread to bluegilled bream swimming around her.

IN THIS ISSUE

MAN did little to overcome friction between moving mechanical parts until the Machine Age dawned. Roller bearings were patented in 1833, and the ball type came along later—with the bicycle. The Fafnir Bearing Company, one of the foremost American manufacturers, entered the business because an official in a pioneer automobile firm thought the price of European bearings was too high. Now Fafnir offers the most complete line of ball bearings in the country and makes 150,000 of them daily in five plants. Our leading article tells the Fafnir story.

•

GOOD track, always essential to efficient railroading, increases in importance as trains grow longer and their speeds higher. But keeping up track by the traditional methods that require a lot of manpower is becoming inordinately costly. As is customary in such situations, Yankee ingenuity is solving the problem by devising surprisingly facile labor-saving machines to do the work. One of the leaders in the field is Railway Maintenance Corporation, of Pittsburgh, Pa., founded by J.B. McWilliams, who left a railroad job 30 years ago to manufacture equipment he had invented for cleaning ballast. A few years ago he added a multiple tie tamper, and more recently he has come up with several other remarkable machines based on his own ideas and those of some engineers in the railroad industry. Page 171.

•

SHORT articles include one on plywood, now in its fiftieth year of production in this country; a description of the Slagjack method of removing slag deposits from steel melting furnaces; and the history of the pioneer typesetting machine, the Linotype, which at first used compressed air in its operation.

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EDITORIAL CONTENTS

The Fafnir Bearing Company—*J. C. Pierce* 164
Machines Are Taking Over Railroad Track Work—*C. H. Vivian* 171
Steel Furnaces Cleaned Quicker 176
Plywood's Golden Anniversary 178
The Machine that Broke the Printing Bottleneck—
Fremont Kutnewsky 180
International Nickel Adds Research Facilities 181
Flexible Cleaning System for Chemical Plants 182
Air Helps Simplify Insulator Maintenance 182
Editorials—Maintenance on the Rise—The Man Hunt 183
This and That 184
Industrial Notes 185
Books and Industrial Literature 190

ADVERTISING CONTENTS

Adams Co. Inc. R. P. 37
Airmatic Valve Inc. 40
American Air Filter Co., Inc. 31
Armstrong Machine Works 40
Babcock & Wilcox Co., The 9
Bethlehem Steel Company 19
Bucyrus-Erie Company 14
Combustion Engineering, Inc. 33
Continental Motors Corp. 24
Coppus Engineering Corp. 5
Crucible Steel Co. of America 8
Diehl Manufacturing Company 38
Dixon Valve & Coupling Co. 25
Dollinger Corporation 3
du Pont de Nemours & Co., E.I. 28
Eimco Corporation, The 11, 12
Hansen Mfg. Co., The 41
Hercules Powder Company 13
Hills-McCanna Company 37
Ingersoll-Rand Company
16, 17, 22, 32, 3rd Cover
International Nickel Co., Inc. 10
Koppers Company, Inc. 36
Lake Shore Engineering Co. 4
Lehigh, Inc. 23
Lunkenheimer Company, The 6, 7
Madison-Kipp Corporation 35
Naylor Pipe Company 26
New Jersey Meter Company 39
N.Y. & N.J. Lubricant Co. 21
Norton Company 20
Punch-Lok Company 40
Sarco Company 37
Schrader's Sons, A. 34
Shell Oil Company 29, 30
SKF Industries, Inc. 18
Sprout-Waldron 39
Texas Company ..... 2nd Cover
Timken Roller Bear. Co. ..... Back Cover
United States Rubber Company 15
Walworth Company 27
Wood's Sons Co., T.B. 39

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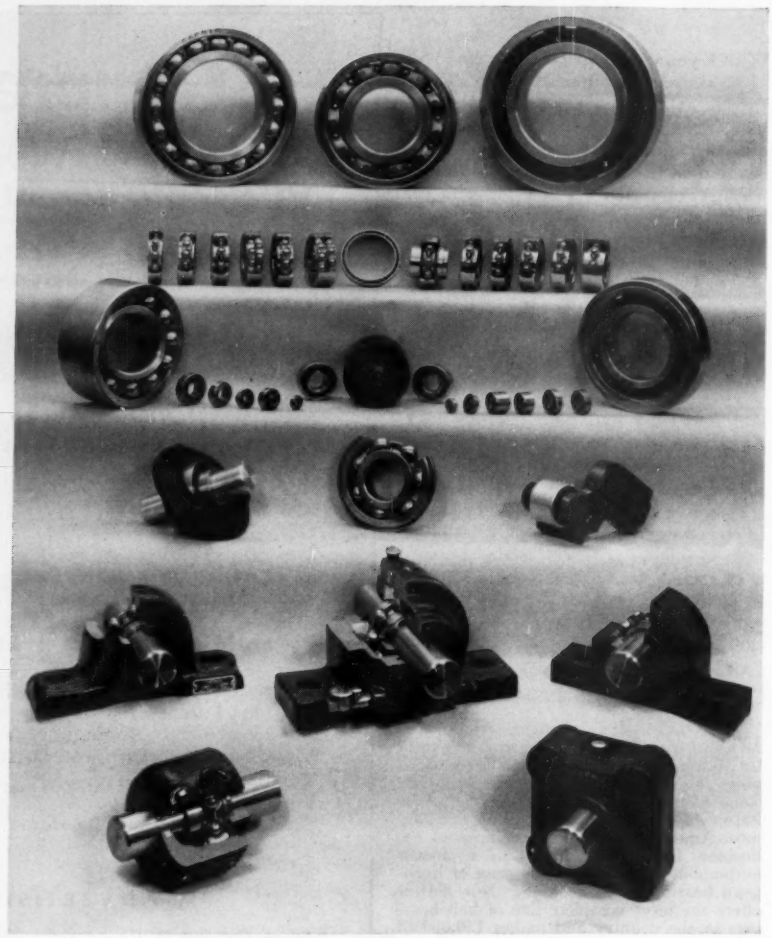
Reducing mechanical friction is the business of

THE FAFNIR BEARING COMPANY

J. C. PIERCE

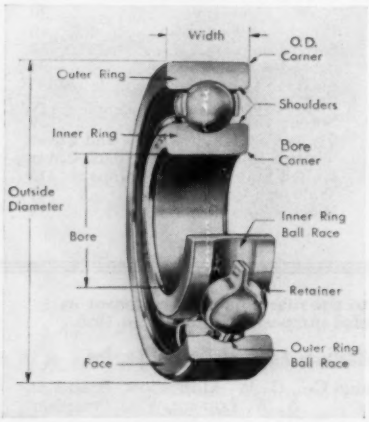


PRODUCTS FOR MANY INDUSTRIES

Typical examples of the 5000 types and sizes of ball bearings made by the Fafnir Bearing Company, including units of its industrial power-transmission line.

THE substitution of rolling resistance characterized by ball and roller bearings for sliding resistance of plain bearings has been acclaimed as a fundamental step in the world's mechanical progress. Where a turning part is incorporated in a mechanical object there may be one or more ball bearings. They are common to industry generally, the average teenage boy knows about them because they are in his bicycle wheels, and nearly every housewife is familiar with them because they are an integral part of many of her mechanical household appliances. In fact, they have become so commonplace that their contribution to our economic and personal welfare is apt to go unnoticed.

Earliest man no doubt learned about the advantages of rolling resistance through experience, for the fact that heavy or cumbersome objects can be moved about more readily on round stones or logs than on a flat surface could hardly have escaped him. But the world was long to await the real need and the realization of mechanical "antifriction" bearings as we know them today. Even the invention of the wheel was to precede by scores of centuries the application of this principle to its axle. Until the advent of the Machine Age wheels turned slowly, and sliding bearings lubricated with animal fat sufficed.



BALL-BEARING PARTS

Section through a single-row radial-type ball bearing that shows the parts common to it regardless of the manufacturer.

The steam engine ushered in the nineteenth century, and with it the fast-revolving wheel, the precisely controlled mechanism and the multiple-part machine that acquainted the manufacturer with his persistent enemy to progress—friction. Fitting into this industrial scheme was the roller bearing, first patented in 1833. With the facilities then at hand rollers were produced more easily than balls and were in widespread use some time before ball bearings made their commercial debut near the close of the nineteenth century by way of a foot-powered mechanism, the bicycle. By that time electrical and gasoline prime movers were emphasizing the need for friction-reducing devices, and the potentiality of ball bearings was soon recognized. Heavy demands for them were made on European manufacturers.

The Fafnir story is typical of American industrial development. A growing market and a desire for independence from the Old Country were the factors that established a trend. Howard S. Hart was vice-president of the American Hardware Corporation, manufacturer of the Corbin automobile and also co-owner of Hart & Cooley Company, maker of warm-air registers. He balked at the high price of European ball bearings for the cars and decided they could be produced in America. Experiments to that

end were undertaken in the Hart & Cooley plant with results that warranted the founding of a separate concern in 1911. It was named Fafnir, after the mythical character in Wagner's opera *Siegfried*, who turned himself into a fierce dragon to guard the treasure of the Niebelungs. The dragon trademark of the Fafnir Bearing Company is symbolic of its products that guard against the ravages of friction.

From seven men with a daily goal of 100 to 150 bearings in a small leased section of the factory, Fafnir has expanded to the stage where it now manufactures 150,000 bearings daily in five plants with more than 21 acres of floor space where some 4000 workers join skills. One of the leading American ball-bearing producers, the firm claims the most complete line of types and sizes in the industry. Fafnir's well-known "attitude and aptitude" slogan expresses the company's attitude as to the need for quality in ball bearings and aptitude for processing that quality into them.

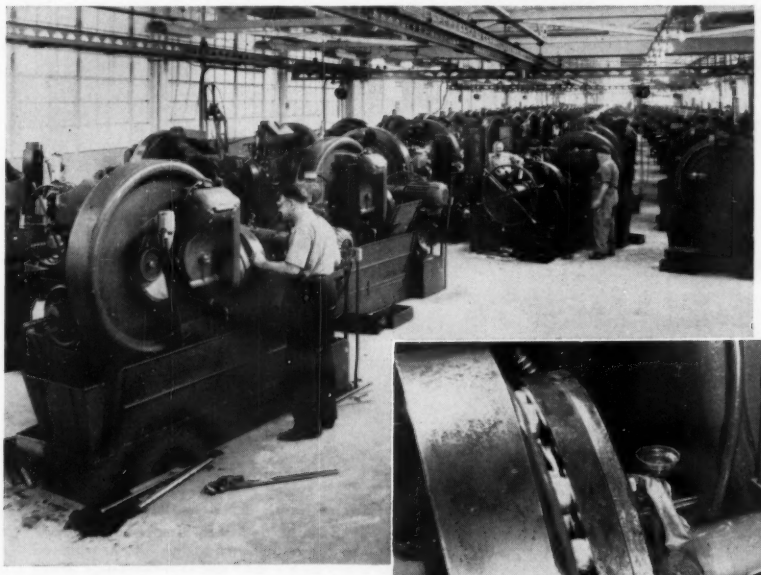
What makes a good ball bearing? The Encyclopaedia Britannica answers that question as follows: "The inherent characteristics of a properly designed and produced ball or roller bearing are, durability, long life and continuity of service; simplicity in construction and operating principle; low frictional resistance and absence of any internal condition in the bearing or surrounding parts which is liable to produce rapid wear; and positiveness and cheapness of lubrication." That straight-forward statement implies exacting manufacture with stringent control of all materials and workmanship. At Fafnir's nearly one-fourth of the employes are inspectors, and this in itself is proof of the high quality of its precision ball bearings. In fact, inspection costs more than production, and the latter must represent a heavy outlay judging by the description of the ball-making process.

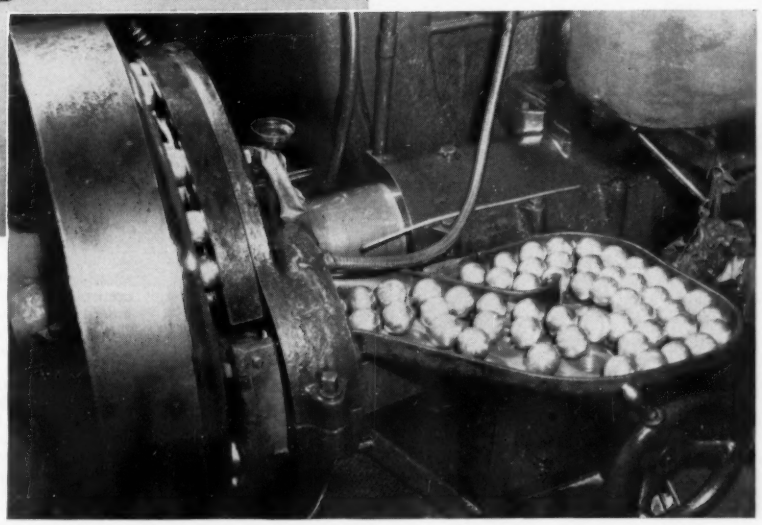
Balls are manufactured to varying tolerance specifications depending on their application. Sizes of Fafnir bearings range from tiny ones weighing a fraction of an ounce to units weighing more than 100 pounds, with ball diameters ranging from $1/16$ inch to 2 inches. All are made from a special semistainless steel—a high-carbon chrome alloy combining a high hardenability factor with favorable toughness characteristics and good machinability in the annealed state. For ball sizes up to $3/4$-inch diameter the stock is coiled wire. Bars are used for larger ones. The latter are hot forged and smaller sizes are cold headed, both by machines that cut off and press the rod sections between two die end punches each of which is in the form of a half sphere.

After the balls are rough formed by the headers they are annealed or normalized in a furnace and put in storage bins according to size to await initial grinding. From this point on abrasives play a major role in the ball-forming operation. The machines utilized for grinding are mainly of Fafnir design and construction. Those that are first brought into play are of the vertical spindle type with a grinding wheel serving as the upper horizontally rotating member and a pressure plate with a ball-retaining groove as the bottom member rotating at a slower speed.

The balls are carried through the grinding cycle in the nonconcentric groove under adjustable pressure and are discharged through a hole in the groove. They are repeatedly returned to the grinding elements by a bucket-type conveyor until seams produced by heading and other major imperfections are removed. This rough-grinding operation is done with Alundum vitrified wheels of coarse grit. Then the balls are fed to similar machines equipped with wheels of finer grit for soft grinding and circulated until they approach true spheres with more refined surfaces.

It is unfortunate that hardening can't be postponed until grinding is completed, for it has been estimated that bearings would cost only about one-tenth as much as they do if the balls could be finish-formed while in the annealed state. So hardening, which produces surface scale and distortion, is the next step. Although a few special designs call for different heat treatments, most of the balls are hardened and tempered as follows: From the preheat zone at a temperature of 1100°F they pass at a slow, regulated speed through a cylindrical, horizontal furnace and thence into the high-





BALL GRINDERS

All the grinding machines pictured above are required to produce from 3 to $3\frac{1}{2}$ million balls per week. The large circular member on each unit is a bucket elevator that returns the balls to the feed port of the horizontal-spindle grinding element. The other view shows large balls between the grinding plates and being discharged for travel to the elevator that returns them for another pass through the grinding cycle.

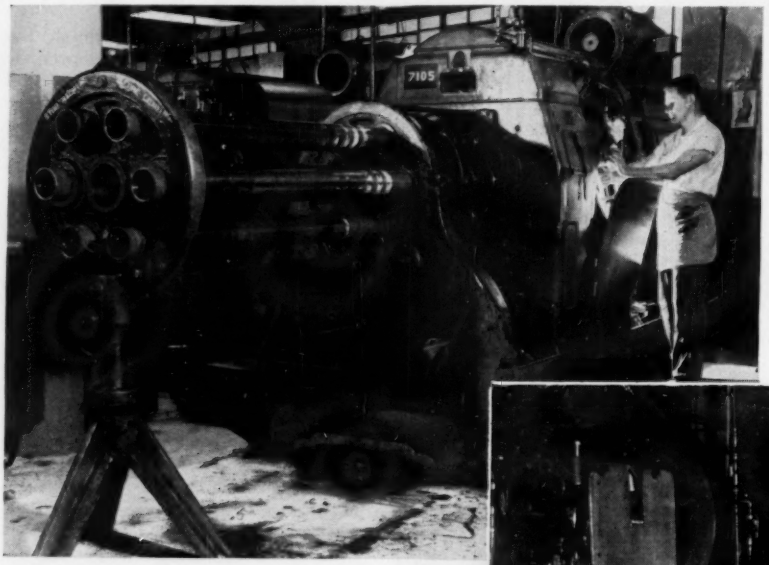
heat (1550°) region, from which they drop into a thermostatically controlled quench of special oil if the balls are under ⅜-inch in diameter or water if they are larger. Tempering to relieve stresses set up by the quick quench is done in a circulating hot-air furnace at between 325 and 400°, depending on the size and end use of the product.

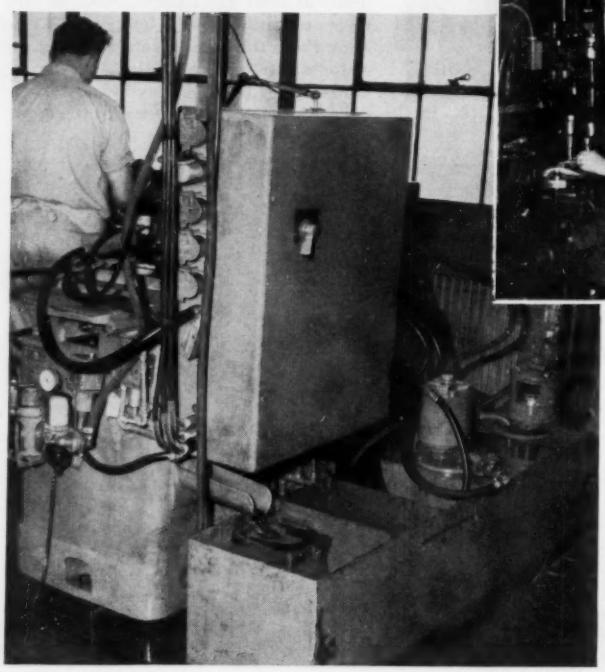
Hardening is followed by first-cut or rough grinding in Fafnir horizontal spindle machines with the grinding member rotating in a vertical plane. The pressure member of this type is a stationary cast-iron plate with grooves concentric to the grinding wheel. The balls are wedged between the two with a predetermined force which causes the axis of rotation of each ball to gyrate in three dimensions. Pressure is adjustable within the range of 4000 to 14,000 pounds. The balls are fed into the machine at the front, make one revolution and fall out for conveyor return and repeated passes. Because both the rotating part and the plate are concentric, grooves are worn in the wheel, which must therefore be dressed periodically.

The last or finish-grind takes place in a machine of the same type but with different grit wheels and is generally done wet with kerosene or mineral seal oil as the coolant. Each is equipped with a gauge for checking ball size and roundness, and the charge (may be 400 pounds for balls of average grade or 20 pounds for high-precision balls) is spot checked at intervals. The product is now of final size with a finish just one step short of that desired.

The balls next undergo lapping, which is usually done on a machine of similar design but provided with two cast-iron plates and with levigated alumina in the coolant. This is a batch operation with the lapping time fixed. Then a run is made with coolant only, and the charge is placed in tumbling barrels for oil-film removal with water and a cleaning compound. Drying is done by tumbling with sawdust or granulated corncobs. There is an alternate finishing method which eliminates lapping and calls for tumbling with lime and water for several hours and drying and final polishing in wooden barrels containing leather scraps which impart the familiar high luster to the spheres.

Inspection includes checking for surface finish, waviness, noise level, roundness and size. Balls less than 1 inch in diameter are given a visual inspection for surface defects after the first grind following hardening and only a spot





WHERE RINGS ARE BORN

From tubes of special steel, fed into banks of multiple-spindle machines like the one shown at the top, are turned out per minute as many as ten intermediate-size rings ready for hardening. Retainers for the balls are pressed out of metal by machines run by women (above). Pneumatic safety control mechanisms are used throughout, and some of the machines are equipped to remove the work with air jets. The bores of small rings are ground on semiautomatic precision bore-grinding units (left) which have a spindle speed of 100,000 rpm. Lubrication, which is of vital importance, is provided by the oil-fog machine on the left end. A pressure switch makes it impossible to start the grinder unless compressed air for the lubricating system is available at the specified pressure. Most of the grinders include air gauges to check ring bores for size and roundness. At the right of the machine is a tank for coolant and two Motorpumps that circulate it.

PRESSURE QUENCH

Rings of thin section would be distorted excessively if quenched after being heat treated with run-of-the-mill rings. From the furnace at the left the operator shown has removed a thin-section ring through an air-operated door and placed it on a sizing plug in one of the quenching presses. A matching plug, pressed down by air-cylinder action, gives the ring its desired dimension as the entire assembly is lowered into a quenching vat, thus making sure that there will be no distortion as the ring undergoes cooling.

check when lapping is completed. Rejects from the first inspection are returned to the circuit that processes balls of the next smaller size. Larger balls are each subjected to a visual check after lapping. Every ball is inspected for subsurface defects by a magnetic-electronic instrument.

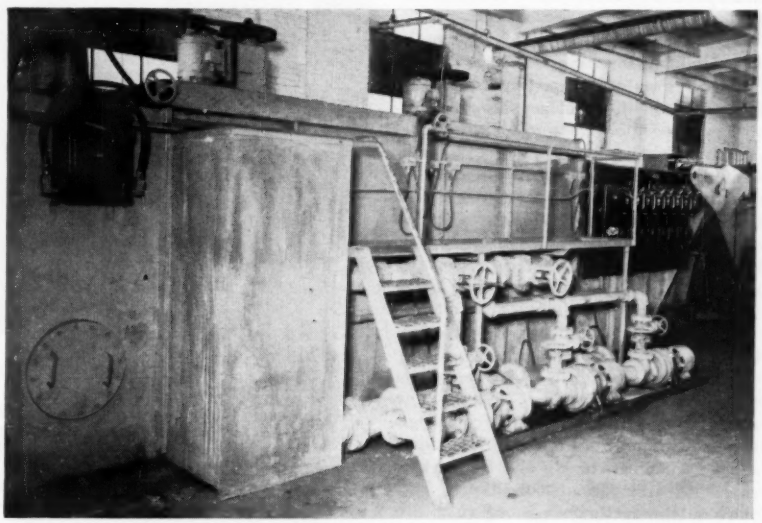
An automatic machine separates the balls by sizes in 0.00001-inch increments at a rate of 11,000 per hour. When matched spheres are being made, finish-grind is invariably productive of balls that are within 0.00001-inch of one another in size and 0.000005-inch in roundness. At the present level of operations some 3 to 3½ million are manufactured weekly. Each ball is in the forming process for 20 to 30 hours, depending on size and degree of precision.

Perfectly shaped and matched balls, though essential, would not contribute to a usable product unless the other bearing components were of the same mechanical precision. This is particularly true of the inner and outer raceways in which the balls roll. The rings for the races must be of the finest quality alloy steel similar to that from which the balls are fashioned, and is generally purchased in the form of annealed bars and tubes obtained from flawless billets from the supplying steel company's electric furnaces.

The radius of curvature of the raceway grooves must be slightly larger than the radius of the balls that will roll in them. The margin of tolerance is slight. If the grooves are tight they will cause sliding friction between the balls and the grooves; if too large they will not give the balls proper support. Multiple-spindle automatic machines start shaping the corners, grooves and outer dimensional limits of the medium- and small-size races, turning out as many as ten per minute ready for hardening and subsequent finishing. Single-spindle automatic units handle tubes up to 10 inches in diameter for larger ones, while turret lathes take forgings up to 36 inches in diameter for the biggest rings.

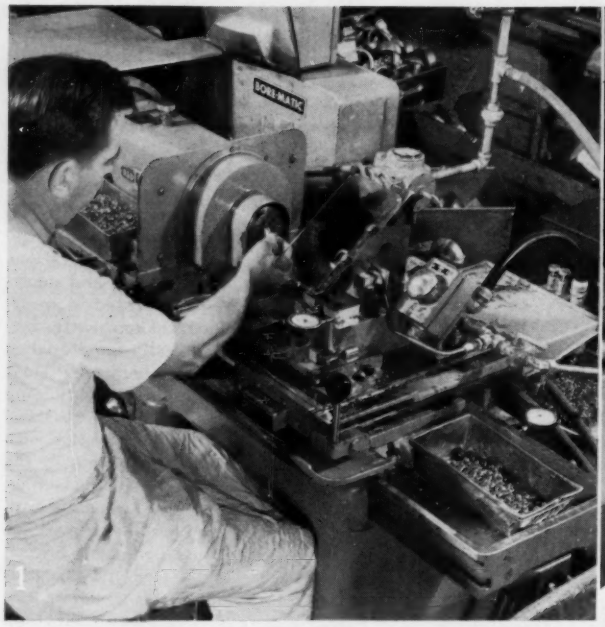
After certain secondary operations such as trimming, cornering and marking, the rings are heat treated in an atmosphere-controlled shaker-hearth furnace that is automatically monitored as to rate of feed and temperature. Heat ranges in the heating and the adjoining tempering furnace are similar to those mentioned previously in connection with the balls. The time of cooling in the thermostatically regulated quenching-oil bath between the two furnaces is controlled by a conveyor which carries the work out and onto a collector. Special designs of rings and balls may be heat treated by other methods, including case carburizing and frequency induction. After hardening, the rings are inspected on Rockwell and magnetic hardness-testing machines. An occasional ring is fractured for visual grain-size analysis.

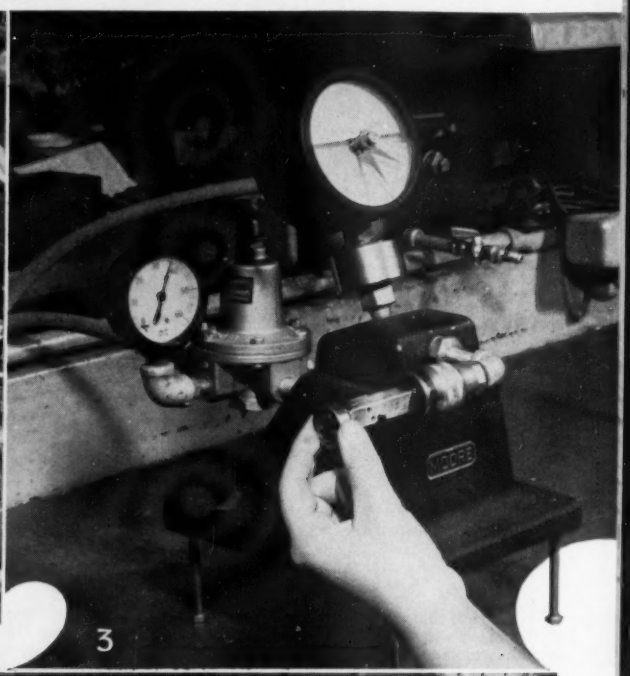
Now the second stage of ring stock removal begins, and this varies from 0.03 to 0.005 inch, depending on the surface. This is a critical operation, or series of operations, and must be performed so

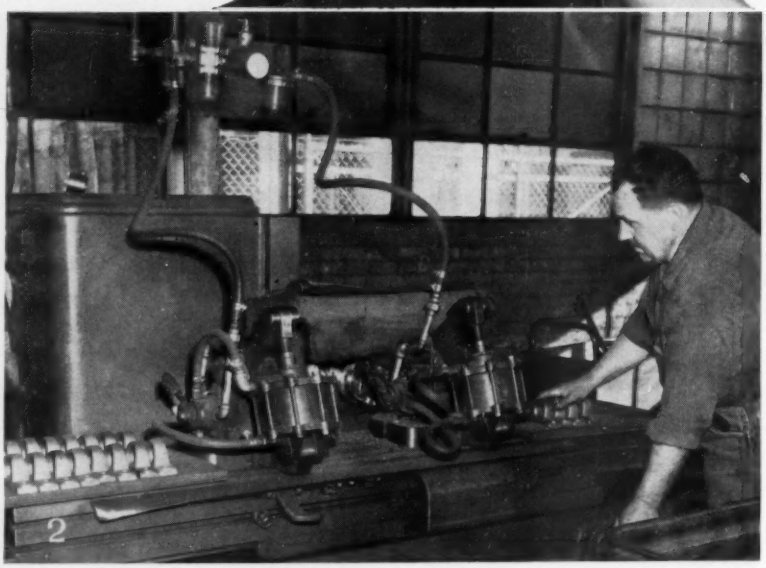


COOLANT CLEANER

Some 28,000 gallons of coolant used for the extensive grinding and milling operations in the main plant is circulated through its distribution system and cleaning facilities Pictured is one of four coolant-clarification flotation units at one of the central stations. Coolant from the machine tools is piped by gravity into the far end of the equipment, which contains a settling compartment for the collection and drag removal of solid material. Overflow is delivered by three 350-gpm pumps to two flotation cells that are under the drive mechanisms on top of the left section of the unit. Flotation separates the remaining foreign matter from the coolant before it overflows into a compartment at the near end to be pumped back through headers on the machine floors above.







that the part is brought to size and to proper surface finish simultaneously, with the final tolerance in dimension in the magnitude of 0.0002 to 0.0006 inch. At this stage the customary inspection instruments such as micrometers, snap gauges and optical images must give way to dial indicators, air gauges, reed-shadow indicators and electro-limit gauges calibrated in 1/20,000 or 1/40,000 inch.

Now the faces of the rings are ground to size and surface quality. This also is a critical step in production because the faces serve as reference planes for the operations on all the other surfaces. For this purpose the rings are held on a circular revolving table by magnetic force while a disk grinding wheel cuts away at the top surface in the presence of a soda-ash solution or coolant. Several cycles may bring about the required accuracy. Thin rings of large diameter would warp if subjected to this treatment and must be ground and lapped by other means.

Here begins the fight against rust, the bearing manufacturer's ruthless enemy that must be dealt with every step of the way until final packaging. This explains the ceaseless plant poster campaign against this harmful deposit, the many special washing, drying and lubricating processes and the air-conditioned sections in the factories. Faced rings are put through a Metalwash Machinery Company machine in which they are spray washed first with an alkaline solution and then water, dried and given a film of soluble oil by air spray. At no point along the production lines are finished surfaces left long uncleaned and unprotected against corrosion. Unfortunately, stainless steel does not possess the high physical properties required

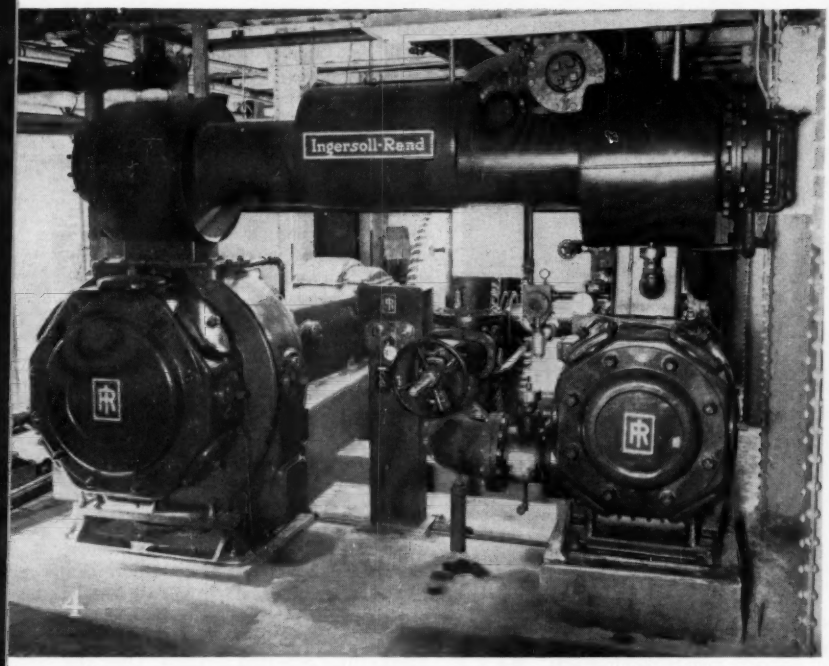
AIR POWER HELPS IN MANY WAYS

1– The air-powered chuck of this boring machine quickly clamps and spins a small ring in perfect alignment as the boring tool is advanced and positioned by a tool slide controlled by the cycling button at the right of the glass shield.

2– Two air cylinders hold pillow blocks in position while their bases are being milled. When the cut limit is reached, each clamp releases the pillow block automatically and another one is put in position by hand. The two clamps operate independently—one is loaded while the other is in service. Hose lines lead down from a regulator-oiler.

3– Here an outer race is being checked for size and roundness with a precision air-gauge setup. Filtered air is supplied at the desired pressure through a regulator. Back pressure caused by fitting a ring over the nozzles in the gauging plug is shown on the indicator. The dial face has movable pointers set at the outer limits of tolerance.

4– An Ingersoll-Rand Class PRE compressor that furnishes most of the air used in the main plant (the four other plants have their own sources of supply). In addition to the applications mentioned elsewhere, air operates a pneumatic-tube system between certain departments and offices, electric-eye door openers, furnace-door controls, machine-tool holding fixtures, abrasive mixers, ball-loading fixtures, hoists as well as rotary tables and performs a multiplicity of cleaning and other services.



for best bearing performance and is therefore not the solution of the rust problem. As compressed air is widely used to remove foreign matter from and to apply the oil, special provisions are made throughout the plants to provide clean, dry air.

The next step in ring manufacture is O.D. (outside-diameter) grinding in centerless-type machines through which the work is fed between a cylindrical grinding wheel and a rubber driver, the latter turning the ring to bring its whole periphery against the wheel several times each pass. At this point the outside diameter of each ring is checked, as well as the faces to determine whether they are parallel and of the correct width. Hereafter inspections become frequent to maintain high standards.

In the case of the inner rings, the bores of two or three of them are ground at a time on a machine that stops automatically when specifications are met. The rings and cylindrical grinding wheel rotate in opposite directions, the latter reciprocating to insure straightness and smoothness. This is a difficult operation where small diameters are involved because they reduce the surface cutting speed of the grinding wheel. In such instances spindles run up to 100,000 rpm. The air gauge used to measure the bores is calibrated in tenths of thousandths of an inch.

Raceway grinding follows. Forming the one in the inner ring is a comparatively simple job, but the method of grinding the race in the outer ring is rather unique in the metalworking industry. This vital surface-finishing work is done by machines with pivotal oscillators, with the radius of the pivot determining the magnitude of the curvature. The grinding wheel is dressed in the shape of the race, and both wheel and ring rotate as cutting progresses. All races are polished after grinding, some by Fafnir-developed equipment.

Now we come to the selective assembly of the races and balls which, like all the other manufacturing steps, is carefully controlled. The races and balls for individual bearings are grouped according to size, which must not vary more than 1/10,000 inch in the case of the former and 1/20,000 in the latter, special gauges checking parts combinations for proper fit. The desired number of balls is placed between the rings, and the metal or plastic retainer is inserted and made fast. If bearings call for seals or shields, these accessories are then put in position. Final inspection is made in air-conditioned rooms by girls wearing lint-free smocks and caps.

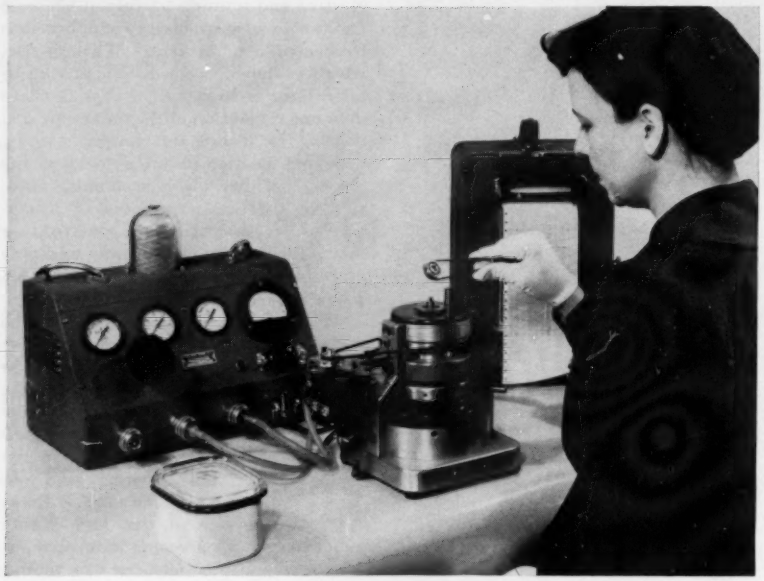
But before they are ready for lubrication, special wrapping and packaging, each bearing is spun on a test motor equipped with instruments that pick up and record excessive vibration. Roughness and unusual noises, which are detected by ear, are causes for rejection. Bearings of the highest precision receive their last check in noise-test rooms where electrical apparatus register the magnitude in decibels and where an analyzer may be used to indicate frequency or pitch of the noise.

Among the most recent testing devices developed by Fafnir is a delicate electropneumatic unit for determining starting and running torques of bearings for low-torque oscillatory applications by instrument makers. This device, which is shown in an accompanying illustration, is so sensitive that it takes only one revolution of the outer ring of a bearing to record its running torque, type and location of any defect and the presence of dirt. It is a valuable addition to the company's line of instruments that serves to check race contour and waviness, radial clearance, end play and noise of its special-precision, super-precision and ultra-precision bearings.

This article, which deals only with the fundamentals of ball-bearing manufacture for the sake of clarity, would not be complete without mention of some of the other plant problems and facilities. Enough stress cannot be placed on ball-bearing lubrication, for too much, not enough, dirty and a wrong kind will knock out a unit in short order. Being acutely conscious of this fact, Fafnir practices what it preaches in its own factories, where some 5000 electric motors from 1/20 to 40 hp, operating at speeds up to 100,000 rpm, must be kept in first-class running condition like its own ball bearings. Moreover, the machines give the engineers a chance not only to apply their technical knowledge but also to note how the bearings stand up in service.

Many factors enter into the choice of a lubricant: should it be grease or oil, what's the best method of admitting it to the bearing, and so on. This phase of the subject is a story in itself; but here we are primarily concerned with the part compressed air plays in this connection. In general, oil is preferred for high-speed and high-temperature applications. Where speeds exceed 5000 rpm, air-mist or air-fog lubrication is recommended. Where grease is applied just before packaging, compressed air lends itself especially well because it exerts uniform pressure against the heavy compound and thus makes it possible to introduce a precisely measured amount into each bearing by aid of special metering devices.

Since the company operates so many high-speed grinders and polishers, it is one of its best bearing customers, and air-mist lubricators are numerous. They are on nearly all its modern spindle machines, and many older ones have been converted to this method of lubrication. By it the oil is vaporized and forced through the bearing housing by dried and filtered air, the quantity applied being carefully controlled by a feed regulator that insures a light film of oil on every moving part of the bearing at all times. Obviously, many of the lubricants used for this and other purposes throughout the plants must be absolutely clean, and this is guaranteed by vacuum filtration through ceramic or sintered-bronze elements.



PRECISION PLUGS

This low-speed torque tester is one of several electropneumatic instruments developed by Fafnir engineers better to meet stringent quality requirements. The bearings of the tester's rotor support must be made with accuracy to guard against erroneous readings. This exemplifies Fafnir's superprecision line of bearings designed specifically for the instrument trade. The girl wears a lint-free smock, cap and gloves and works in an air-conditioned room.

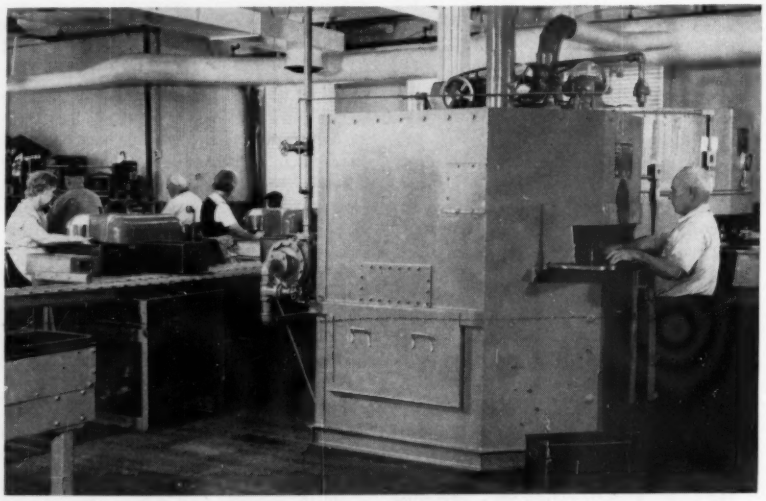
Although the term antifriction might seem to indicate that bearings of this type do not have to be oiled, nothing could be farther from the truth. Lubrication is essential to minimize friction between balls, raceways and retainers; to protect the accurately ground surfaces from corrosion; to keep out foreign matter and to help dissipate the heat incident to the operation. Modern sealed, prelubricated ball bearings may have been developed in consequence of repeated infractions of manufacturers' instructions either through carelessness or ignorance.

Fafnir's complete line of ball bearings includes some 5000 sizes and types. That staggering figure is readily accounted for when it is known that there are many different types in each size and that each type varies widely in design, degree of precision, retainers, shields and seals. The customer's selection is always based on his particular application and is normally available from stock. However, if a user encounters a problem that necessitates a special ball bearing, Fafnir engineers can be called in and may solve the difficulty by designing still another one.

A few of the more common types include: single-row (balls) radial bearing intended primarily for carrying radial loads; angular contact bearing designed to carry combined radial and thrust loads or only thrust loads; double-row bearing that serves to carry combined radial and thrust or thrust loads alone from either direction; self-aligning bearing to compensate for housing variations and shaft misalignment or deflection; flat thrust bearing to carry pure thrust loads only. Retainers may be of the spring or more common rigid type made of pressed steel, pressed bronze, solid machined bronze, plastic or sintered metal. Shields and seals may be fashioned of metal, felt, rubber or plastic in a large variety of styles.

Fafnir bearings range in bore size from ⅛ inch to 15 inches. They are distributed nearly everywhere throughout the globe and serve makers of such products as automotive vehicles and aircraft; portable and machine tools; textile, farm and air-conditioning equipment; household appliances, electric motors and instruments; and construction, mining and woodworking machinery. One of the company's plants, known as the Industrial Division, is what might be termed a "product specialist." It is devoted largely to the making of housed units like pillow blocks, bearinged flanges and patented self-locking shaft collars for power-transmission service, as well as similar standard or special types for diverse industries.

The average service life of an antifriction bearing operating under known load, speed and mounting conditions can be accurately forecast. It will ultimately fail through fatigue of the material in much the same way as an iron wire breaks after repeated bending. Over the years manufacturers have done much to prolong that life, and they are continuing to make progress in that direction through persistent research, sound engineering and factories equipped with the best machines available operated by men and women skilled in their respective crafts. In return they are justified in asking users to handle the bearings in a manner befitting these jewels of industry by following the correct installation and maintenance procedures laid down for them.



BEARING WASHERS

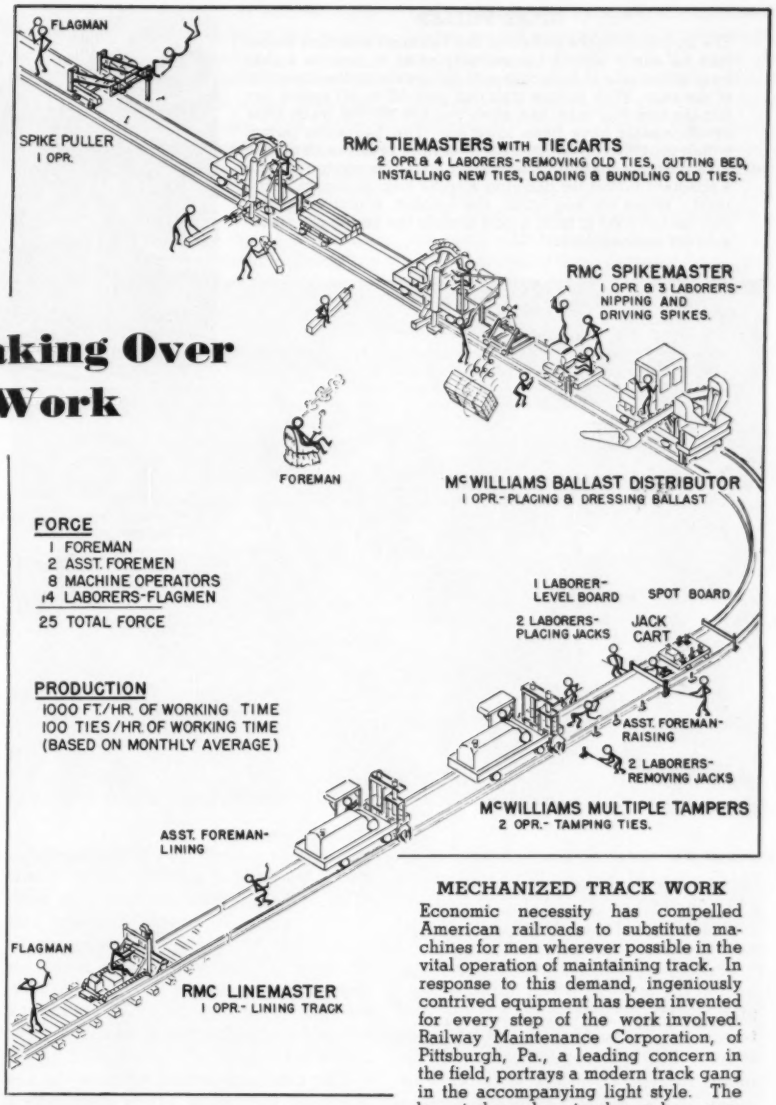
Finished bearings are hand placed in holders on a rotary table in a washing machine and subjected to successive sprays of different solvents directed from many angles as they pass through the machine. At the final stage, a blast of compressed air removes excess solvent. In the left background are two smaller washers that operate in the same way.

Respite For Gandy Dancers

Machines Are Taking Over Railroad Track Work

Ingenious Robots Enable One Major Carrier to Reduce Manpower 80 Percent

C. H. VIVIAN



MECHANIZED TRACK WORK

Economic necessity has compelled American railroads to substitute machines for men wherever possible in the vital operation of maintaining track. In response to this demand, ingeniously contrived equipment has been invented for every step of the work involved. Railway Maintenance Corporation, of Pittsburgh, Pa., a leading concern in the field, portrays a modern track gang in the accompanying light style. The layout shows how track can be reconditioned with only 25 men, which is less than one-fifth the number that was needed only ten years ago. And as machines don't tire or vary their actions, the job is being done better and faster than ever before. The pictures that follow show all the machines indicated here except the jack cart.

ONE of the prime requisites in running a railroad is, obviously, to keep the track in good order. This is essential not only as a safety measure and for passenger comfort but also to protect the rolling equipment from battering itself and the track unduly. Keeping up track, bridges and appurtenant structures comes under the heading of maintenance of way, and the expense involved has long taken a deep bite out of railroad revenues. Across the country, it now costs rail carriers from ten to fourteen cents for every dollar they take in. Last year's expenditures for this purpose by one of the nation's largest rail systems averaged a staggering $375,000 per day.

With competition from trucks, buses and airlines getting stiffer all the time, railroad managements are striving strenuously to find ways to keep their current proportion of the transportation business, or even to recover some of it that they have lost. To do this, they realize they must improve service and keep their charges reasonable.

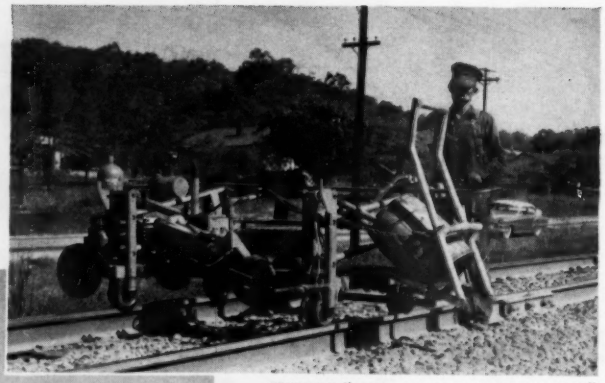
Under these conditions the lines are ever watchful for means of reducing operating costs. Maintenance of way, especially trackwork, has traditionally called for a lot of manpower, and it was inevitable that steps should be taken, sooner or later, to mechanize some of the jobs involved, just as has been done in other lines of industry. A start was made during World War II when the supply of laborers became extremely short, and the movement has been accelerated since then.

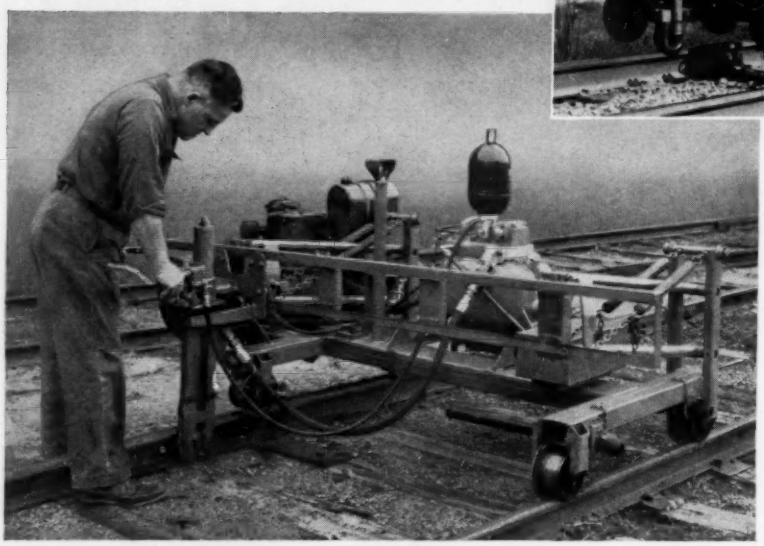
In our September 1953 issue we discussed this trend and described a multiple tie tamper that enables one man to do the work that formerly required sixteen men, each running an individual tamper. The function of a tamper is to drive ballast under the crossties to provide a smooth, well-drained roadbed. This used to be done by laborers wielding forks, picks and bars. Then the air-operated tamping tool was developed which increased the amount of work a man could do and also lightened the physical labor. However, it still called for considerable muscular effort. This was finally eliminated by the multiple or gang tamping machine.

The gang tamper we described—there are others on the market—is made by Railway Maintenance Corporation, of Pittsburgh, Pa. Meantime the same concern has brought out additional mechanical aids that perform some of the other operations in the track-maintenance cycle. Their combined effect is to multiply by five or six the work a man used to do with simple hand-held tools. Only fifteen years ago, a gang that went over the line periodically to renew bad ties, clean ballast, raise the track from 1 to 5 inches, tamp it, line it up and leave everything shipshape, totaled from 125 to 140 men. Twelve of them probably ran hand-held tampers, which were about the only mechanized equipment on the job. Today, in startling contrast, Railway Maintenance Corporation has a setup that

SPIKE PULLER

The hydraulic spike puller on the Fairmont machine below may be easily moved transversely so as to remove spikes from either side of both rails without reversing the direction of the car. With it, one man can pull 15 to 20 spikes per minute and two men can push the car off the track after set-off wheels have been lowered. The hydraulic pump, which provides up to 3000 psi operating pressure, is driven by a gasoline engine. The machine may be equipped with a special bracket for carrying a spike keg, as shown at the right. When the keg is full, the bracket, which is hinged, may be lowered to form a skid to slide the keg to the trackside for removal later.





COURTESY "RAILWAY TRACK AND STRUCTURES"

will do the same work with a force of 25. It is presented pictorially in the accompanying sketch. It is claimed that the equipment will save its cost in well under a year.

The spike puller which leads the line-up and the jack car which appears about midway in the procession are the only two pieces of equipment not made by RMC. The spike puller, built by Fairmont Railway Motors, Inc., of Fairmont, Minn., is a self-propelled machine ridden and controlled by one man. The pulling mechanism is operated by hydraulic power and can extract from 20 to 25 spikes per minute. The jack car, constructed by Matisa Equipment Corporation, Chicago, Ill., is an ingenious vehicle that does some amazing things, as will be explained later.

New RMC machines in the assemblage are the Tiemaster, Spikemaster and Linemaster. The Tiemaster removes worn or damaged ties and puts in new ones. This has heretofore been done entirely by men with tongs, and as a tie weighs anywhere from 200 to 350 pounds it is very strenuous work. The mobile unit can replace ties at an average rate of one every 50 seconds and at about one-fourth the former cost. The operator who rides the machine and two men on the ground perform all the work.

The Tiemaster weighs 9 tons, is 12½ feet long, 9 feet 8 inches high and powered and propelled by a 60-hp diesel engine. It can travel between jobs at speeds of 5½, 13 or 26 miles per hour. In service, it is put in proper position and clamped to the track. Then hydraulic spuds or lifting cylinders on each side elevate the track and the machine resting on it sufficiently to clear the tie plates from which the spikes have been extracted.

The mechanism that replaces the ties is simple but novel. It is essentially a heavy, segmented chain of tie width that travels back and forth under the rails. As it retracts, it moves up the side of the machine and on to a curved track over it. Like a person's fingers, the chain is built to bend in only one way. When it straightens as it goes under the rails it becomes a rigid bar or ram which bears against the end of the tie to be removed and pushes it out on the other side of the track, at the same time shoving out enough ballast to scalp or lower the bed an inch or so.

When the old tie comes out on the opposite side, a laborer attaches tongs to it and it is then lifted by means of a line pendent from a hoist on the Tiemaster, swung around and deposited on a trailer car. When sixteen ties have been loaded they are secured by two steel straps and the bundle is dumped alongside the roadbed by tilting the bed of the car. One side of the bed is hinged, permitting the loose side to be raised by the hoist line. When the car is not used and the ties are left along the right of way for later disposal the speed of tie removal is almost doubled.

The replacement tie has, meantime, been spotted on the track shoulder close to where the old one came out and a metal strap, with a hook on one end, has been spiked to it. This hook is engaged by the end of the ram, which is then retracted, drawing the tie into position in the bed of the discarded one. A workman disengages the ram, removes the strap from the tie and puts it in an inclined chute that delivers it to the opposite side of the track for reuse.

The Spikemaster is a small, wheel-mounted machine that is air powered except for one movement. It carries an Ingersoll-Rand gasoline- or diesel-driven 125-cfm rotary Gyro-Flo compressor which supplies air for four spike drivers as well as an I-R 5.3-hp motor that propels the car through a 4-speed transmission at speeds up to 20 miles per hour. In operation, two tonglike nippers descend and grasp the tie at two points midway between the rails and exert a strong upward pull that holds it firmly against the tie plates and rails during spike driving.

The spike drivers—Ingersoll-Rand PB-8 models—are arranged in pairs on each side of the machine, one tool inside and one tool outside of the rail, and in positions corresponding with those of the holes in the tie plates. The spikes are set in advance, and from his seat the operator can see whether the tools are in exact alignment with them. If not, he can move the carriage forward or backward by means of a hydraulic piston powered by a Vickers "Power-Pac" pump that is run by belt from the fan shaft of the compressor engine. The position of the spike drivers is adjustable to meet all standard patterns of tie-plate openings. When everything is ready, an air cylinder lowers the carriage and an automatic valve admits air to start the tools as soon as they are in contact with the spikes. Overdriving is prevented by

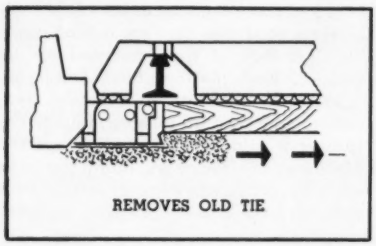
two vertical bars that are mounted on the carriage and descend far enough to meet the rail top. Actual spike driving takes about five seconds.

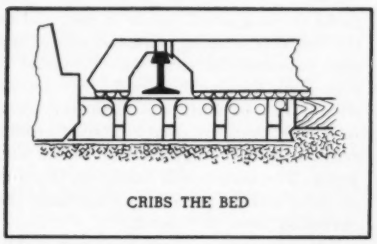
All controls are mounted together, and air valves provide for fingertip operation. The machine has air brakes actuated by diaphragm cylinders similar to those used on trucks and buses. It has a horn like those now used on some western ranches for calling cattle, and its distinctive sound warns the trackworkers when a train is approaching. It is more audible than an automobile horn and cannot be confused with the latter.

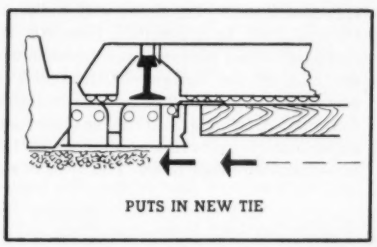
The Linemaster, which brings up the rear, is designed, as its name indicates, to line up track that may have become "wavy" during the preceding work. Lining has traditionally been done by men with pry bars who, under the direction of a foreman sighting along the track, inched it over. Two men—the Linemaster operator and the man doing the sighting—now suffice for the job.

The machine is hydraulically operated and mounted on crawlers narrow enough to permit it to travel inside the rails. A rotating spud is worked into the ballast between two ties to give the unit a firm anchorage. The operator, with unobstructed vision ahead, can then actuate either of two opposed cylinders to bring a pad to bear against a rail to push the track over in the direction indicated by the man with the sighting scope.

In addition to these recently developed RMC machines the sketch shows two

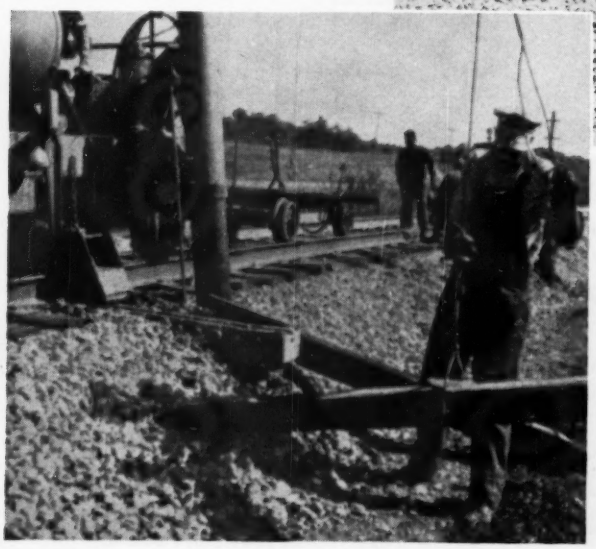


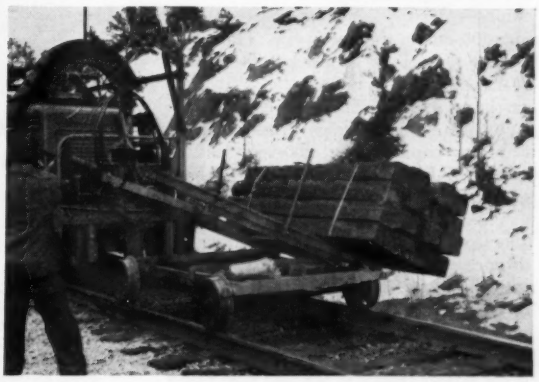


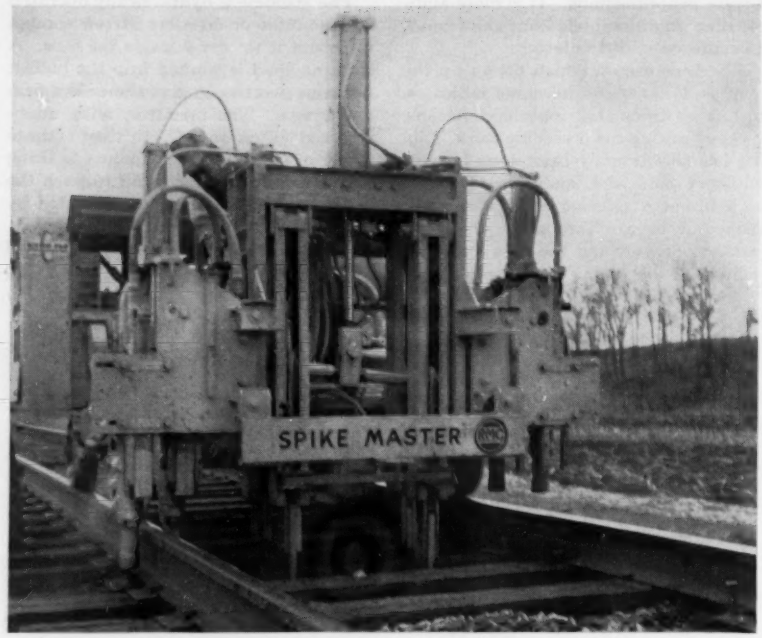


TIEMASTER

This machine takes the hard work out of tie replacement and is claimed to do the job at one-fourth the cost of any other known method. It requires only one operator and two attending laborers. The over-all equipment is seen directly below. The picture at the bottom-left shows the ram, protruding from the ballast, that pushes out the ties. A new tie will be attached to it and drawn into place as it is retracted. A tie that has just been removed is about to be swung around by a hoist line and deposited on a car in the rear. When a dozen ties have been loaded, they are bundled with steel straps and dumped off by tilting the car bed with a line from the Tiemaster's hoist, as illustrated at the bottom-right. The three sketches show the sequence of operations and also indicate (in the first and second panels) how the ram cribs or lowers the ballast bed before a new tie is put in.







SPIKEMASTER

Two sets of tongs underneath the machine grasp a tie and pull upward to hold it firmly against the tie plates and rails while spikes are being driven. The four spike drivers are arranged in pairs on each side, and one can be seen driving the outside spike that holds the near rail. Another spike has been set for driving at the extreme right. The machine is operated and propelled by compressed air supplied by its own Gyro-Flo 125-cfm compressor, which is powered by a gasoline engine.

others that have been available for some time: a ballast distributor and a multiple tamper. Both are identified by the name "McWilliams," and this refers to J. B. McWilliams, founder and president of RMC. The ballast distributor is a self-powered, one-man unit that picks up ballast from the intertrack space and shoulders and puts it in position for tamping. It covers from 800 to 1200 feet an hour and does the work that once required 30 to 40 men with hand forks.

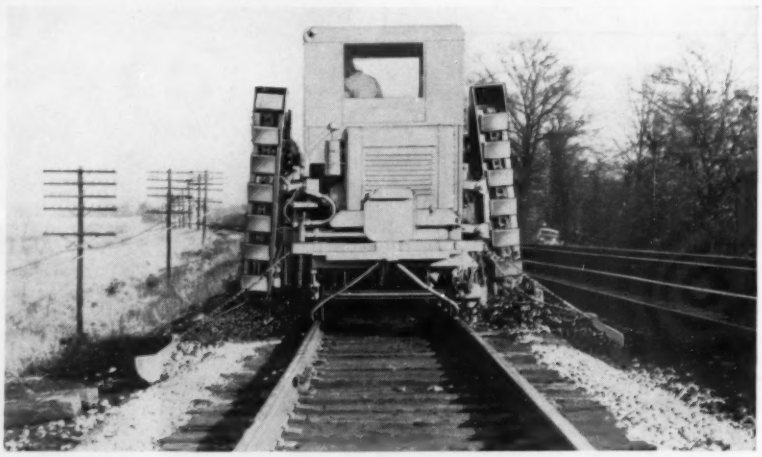
The multiple tamper has been in use for about four years. Since we last described it, the machine has been shortened 30 inches, certain parts have been strengthened better to withstand the rigorous service and the 315-cfm Gyro-Flo compressor has been supplanted by a Size 600-cfm of the same type. The latter change has served to quicken the action of raising and lowering the split-head carriages, each of which is equipped with eight tampers, thereby increasing the tamping capacity by 200-250 feet of track per hour to around 700-750 feet, or approximately 50 seconds per tie.

The sketch shows two machines, the Tiemaster and the multiple tamper, in duplicate, because that setup is required to keep up the indicated rate of progress of 1000 feet per hour. The rate is determined, naturally, by that of the slowest machine, which is the tamper. Its speed is limited by reason of the fact that every tie has to be tamped. The number of ties to be replaced varies considerably on different sections, but it is usually high enough to call for two Tiemasters. Each pair of machines works in a leap-frogging manner. The tamper in the lead tamps every other tie, as does the second unit. Similarly, each Tiemaster usually renews alternate ties.

The jack car previously mentioned travels just ahead of the first tamping machine and carries the jacks that are used in raising the track 1 inch to 1½ inches to permit working the ballast under the ties. It is a 4-wheeled, self-propelled vehicle that operates substantially unattended and acts with almost human intelligence. As the lead tamper moves forward, two men remove the jacks from the track immediately ahead of it and place them on either of two collapsible platforms that are mounted one on each side of the front end of the tamper. Each platform holds five jacks.

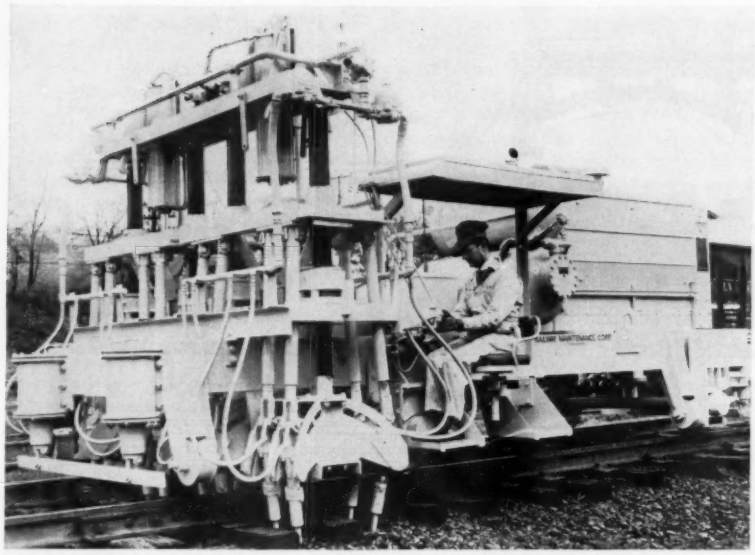
When the jack car, on its return from delivering a load up forward, bumps the tamper it trips a lever that causes the platforms to collapse and dump the jacks into the car. At the same time, the latter reverses its direction and moves ahead at a speed of about 3 miles an hour. The workers previously mentioned leave the jacks at designated points of use, and as the last one is being removed one of the men reverses the car's direction and it goes back for another load. In case he should fail to shift the lever for some reason, a skate or shoe is placed on the track a few rail lengths ahead of the lead jacks. The carrier will run up on this and remain, with its wheels turning, until the reversing lever is thrown.

Thus far our account has been on the theoretical side—has dealt with a hypothetical job. It is possible, however, to consider actual performance because essentially all the equipment discussed is now being utilized by one of the nation's foremost railroads and its satisfactory experience to date has aroused great interest among other lines. The system re-



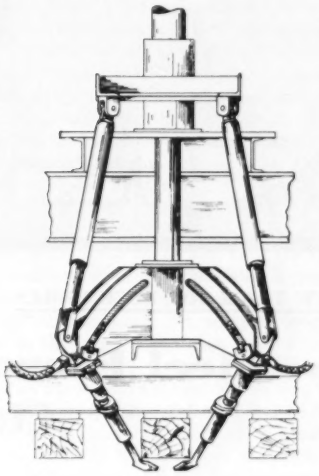
BALLAST DISTRIBUTOR

This self-propelled machine picks up ballast from the shoulders, elevates it and distributes it in the rear in correct position and thickness for tamping, meanwhile dressing the shoulders and intertrack spaces. It covers from 800 to 1200 feet of track per hour and does the work that once required from 30 to 40 men. Either or both of the gathering wings that scrape the ballast in from the sides may be operated, as desired. A 60-hp gasoline or diesel engine powers the machine.



MULTIPLE TIE TAMPER

This completely air-powered machine, which is run by one man, operates sixteen tie tampers in unison, doing a more uniform and better job than sixteen men with individual tools. It will tamp from 700 to 750 feet of track per hour. The split head, each half of which handles eight tools, permits tamping under one rail only where conditions call for it. A Gyro-Flo 600-cfm compressor mounted at the rear furnishes power for the tampers, propulsion motors and head-lifting cylinders. The sketch below shows how the tampers work under a tie from both sides.

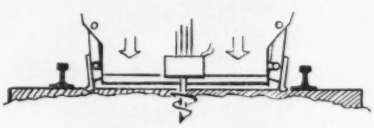


ferred to, which must be unnamed here, has ordered up to 30 of one of the machines listed and lesser numbers of the others. It is apparent, then, that it intends to adopt the new mechanized procedure for all its future tie-renewal and track-ballasting work.

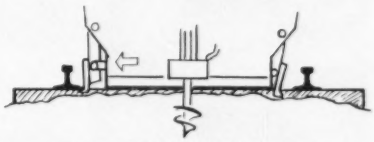
The road in point renews ties every five years, and the number replaced in a given stretch naturally affects the speed of the entire chain of operations, which railroad maintenance-of-way men call "putting up" track. The normal pace is reported to be around 900 to 1000 feet of track per hour. On a representative day, with the track available for work for a period of seven hours and fifteen minutes, the crew put up a mile and replaced 435 ties, which was exactly one per minute.

Ten machines and 27 men, including a foreman and two assistants, were in the line-up, and the equipment was nearly the same as that in our sketch. At the head, preceding the spike puller, was a Kershaw ballast regulator that plowed ballast away from one end of each tie to be removed in order to prepare the way for the Tiemasters. That was only a part-time job for the ballast regulator, which dropped to the rear of the line later in the day to "dress" the ballast after all operations had been completed. A second machine of the same kind was stationed just behind the Spikemaster and performed the same work the McWilliams ballast distributor is doing in the drawing.

Before a gang starts operations, the ties that are to be replaced are marked in a way that identifies those that are fit for further use in either secondary mainline or yard track. A third marking is given those that are unfit for further service and will be burned. Following their removal, ties bearing the same number are bundled together. Another preliminary job is the distribution of new ties and enough ballast to take care of raising and then dressing the track at the conclusion of the work. If the old ballast needs cleaning, that also is done ahead of time, as well as all necessary ditch cleaning and repairing of battered rail ends by welding.



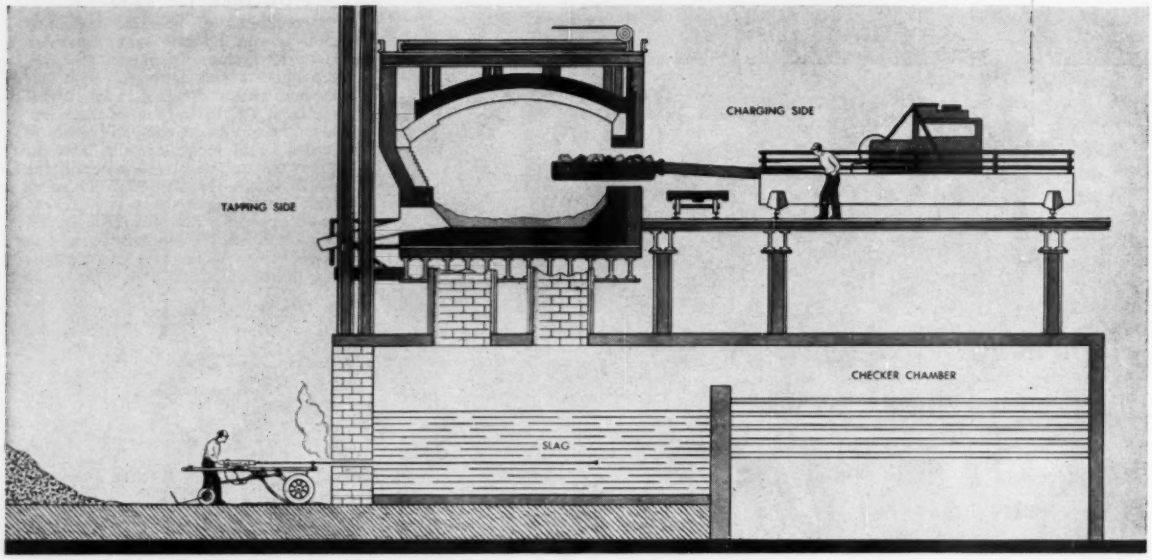
Lining head lowered and spud driven into roadbed.



Track moved horizontally in either direction by hydraulic cylinders.

LINEMASTER

This crawler-mounted, hydraulically operated machine is narrow enough to travel between the rails. It is first anchored in position (see sketches) by driving the centrally located rotating spud into the roadbed between two ties. Then, by the action of either of two opposed pistons in the head, the track is moved over as directed by a man sighting along it. Thrusts of from $1/16$ inch to 6 inches can be made with precision.



HOW SLAGJACK IS USED

Section through a typical open-hearth steel furnace. Most of the slag floats on top of the molten metal and is drawn off with it. Some, however, is swept out by the fuel gas that blows across the charge and falls into pockets underneath and on each side.

NEW TRICK FOR ROCK DRILLS

Steel Furnaces Cleaned Quicker

Holes for blasting slag deposits drilled through brick wall as production continues

ASIDE from the more conventional services performed by rock drills in their predominating fields of mining, quarrying and construction, the machines are being used increasingly in various industrial operations. One of their most interesting applications is the drilling of blastholes in accumulations of slag in open-hearth and electric steelmaking furnaces. For this purpose Ingersoll-Rand Company has developed special equipment called the Slagjack.

In the case of the more prevalent open-hearth work, the technique consists in drilling 3-inch-diameter horizontal holes through the brick wall or bulkhead at the rear or tapping end of a furnace and on into the slag deposit in each of the two chambers that are provided to hold it. These pockets vary in dimensions according to the size of the furnace. In one mill that has reported on its experience with the Slagjack they are 14 feet 3 inches wide by 23 feet 3 inches long, and the slag normally collects in them to a depth of about 6 feet during a furnace run of approximately six months. In another plant the chambers are 9x12 feet and the slag ranges from 4 to 8 feet deep by the time the furnace is shut down for the periodic cleanup and reconditioning.

DRILL AT WORK

The drill runner stands at one side and out of the way of steam and cuttings that issue from the hole.

It was formerly the practice for men to enter a furnace to drill blastholes in the slag with hand-held drills or to chip it out with paving breakers. Either course necessitated shutting down the furnace at least eight hours beforehand and tearing out the exterior brick wall to provide access for the workers and equipment. Even though the slag was wet down thoroughly, it remained so hot that the men commonly wore 2-inch-thick wooden slabs attached to the soles of their shoes and had to be relieved every 10 to 15 minutes so that they might cool off. The job averaged 450 man-hours of labor and took four days, including the 8-hour precooling period.

Where the Slagjack method is used, the furnace remains in operation during the drilling of the holes. As the men are stationed outside of it they are not af-

fected by the heat and can work a normal shift without relief. Furnace "down" time is consequently reduced an average of 75 percent and the reconditioning cost is also cut considerably. Moreover, a former hazard in connection with the job has been eliminated, and this is important in the safety-conscious steel industry. The demolition work that must be performed on the hearth floor could not be started so long as men were toiling in the pockets underneath. With a Slagjack in service, no one has to enter this dangerous location.

The Slagjack consists of a DB-35 drifter drill on a JHM rubber-tired wagon mounting. The rig is highly mobile, and the carriage can be easily adjusted to the desired working height. Hollow, round 1¼-inch drill rods in successive increments of 6 feet—that is, 6-, 12- and 18-foot rods in sequence—are used to put in an 18-foot hole, and Carset (tungsten-carbide insert) bits are employed better to withstand the wear and the high temperature.

Successful drilling of the red-hot slag requires controlled cooling at the point of penetration, and this is accomplished by forcing water through the hollow steel with the aid of special equipment. In normal "wet" drilling, water passes through the drill and then into the rod, but this arrangement does not supply enough nor does it maintain adequate pressure to cool the slag effectively. These deficiencies were overcome by Ingersoll-Rand by means of a special swivel that introduces water directly into the drill rod, and this appliance is largely responsible for the success of the Slagjack method.

The swivel is a bronze sleeve that fits around the steel a few inches from the shank end. It has a side water inlet that is threaded for attaching a standard ½-inch connection. Ports drilled through the walls of the hollow rod admit water from the swivel, and double O rings, that expand under water pressure, form seals at both ends of the sleeve and prevent leakage. The water travels through the drill rod and out by way of four holes between the wings of the 4-point bit. The latter was developed in the Pittsburgh area, where it is known as the Loginotti bit.

The slag is in a semiplastic condition when it is drilled, and it is important to choose a machine that will penetrate it at a fair rate of speed but not so fast as to cause the hole to drift off line and bind the steel. Experience has shown that the DB-35 has just about the right power for the job. Similarly, Carset bits have the properties needed to withstand the abrasion and the intense heat. In open hearths, they average around 180 feet of hole before being discarded; in electric furnaces, where the temperature may exceed 2000°F, bit life ranges from 40 to 50 feet.

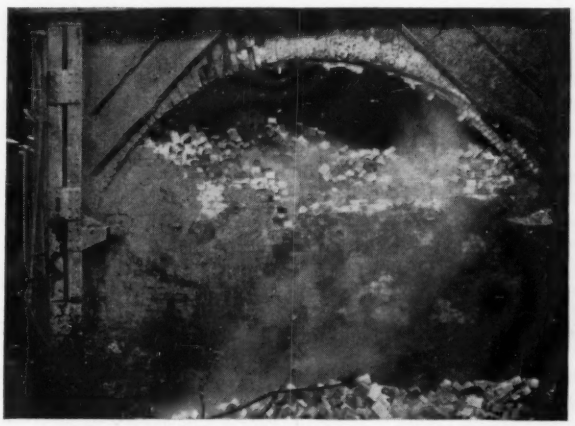
After a hole has been drilled, a small pipe, usually ¼-inch in diameter and long enough to reach all the way in, is inserted and water passed through it to keep the opening cool until it is blasted. This is done with Du Pont Nitramon "S," which cannot be set off by heat alone. It is detonated with an Amatol primer that is electrically fired. One hour of cooling is enough to permit charging and blasting, but better fragmentation is obtained if the water is allowed to circulate longer. Normally, 60 percent or more of the material is broken into pieces small enough to be loaded by a ½-cubic-yard dipper or bucket of a backhoe shovel.

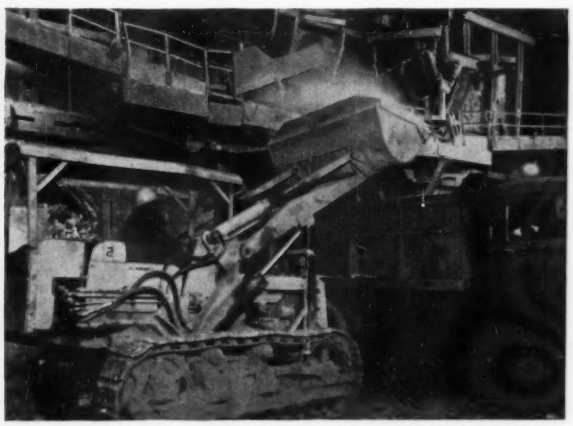
Blasting breaks down the rear brick wall or bulkhead and makes it possible to move in crawler-mounted loading equipment, which may be a backhoe shovel, a high-lift shovel or an Eimco loader. The material is dumped into trucks and hauled to disposal areas. Where a backhoe is utilized, its bucket is usually provided with four hardened alloy-steel teeth that can break up most of the chunks that are too large to be handled readily.

Slag in electric furnaces is drilled and blasted in a manner generally like that described. In addition, the crucibles may be cleaned out while still hot by replacing the drill on the JHM mounting with a 110-pound R-30 paving breaker fitted with a moil-point steel 6 or more feet long. The same combination also serves in the Pittsburgh district to clean out hot metal mixers. Here the problem is to remove old refractory material which has been so permeated with iron that ordinary paving breakers will not do the work. For this purpose the R-30 is equipped with either a ring handle for sling or tower mounting or with a "T" grip for hand holding.

The Slagjack was introduced in the Pittsburgh area in the summer of 1951, and more than 30 of the rigs are now operating there. Some are also in use in other steel-producing sections. In a typical Pittsburgh mill, where open hearths are in the larger size range, two or more blastholes about 6 feet apart and 18 inches above the bottom of the slag are drilled through the back wall and 18 feet into each deposit. Drilling is started from 24 to 32 hours before the furnace is scheduled to be taken out of service.

The net drilling time for the four holes is from two to three hours—the remainder of the elapsed time being spent in moving the Slagjack into and out of position so as not to interfere with the operation of the furnace. This also involves clearing the area occupied by the drill after each tapping of the furnace. The blasted slag is loaded by two backhoe shovels—one in each pocket of the furnace. It takes between 24 to 36 hours to remove about 2150 cubic feet of slag from each chamber.



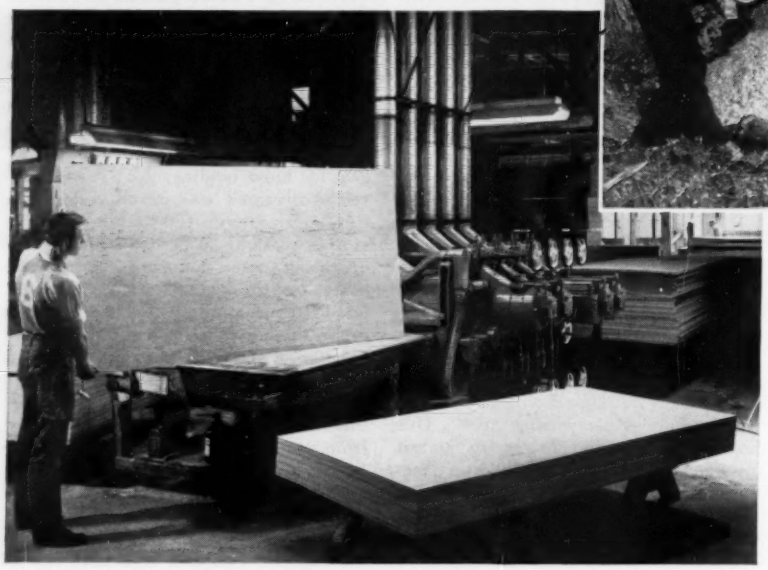


BLASTING AND LOADING

The picture at the left was taken soon after a blast had shattered the upper part of the brick wall. The other view shows a high-lift loader depositing broken slag into a truck for disposal.

PLYWOOD'S GOLDEN ANNIVERSARY

'Wood sandwiches' show best gain in sales of all forest products



WEYERHAEUSER TIMBER COMPANY

FROM FOREST TO FINISH

Loggers using a power saw fell a big Douglas fir in from seven to ten minutes. They are seen above putting in the undercut on the side of the trunk toward which the tree will fall. The other pic ture shows sheets of bonded plywood in a mill finishing department and a sanding machine that smoothes their surfaces.

THE fiftieth anniversary of the establishment of the fir plywood industry in America will be observed from June 19 to 21 at Portland, Oreg., under the auspices of the Douglas Fir Plywood Association. Although other varieties of wood are utilized to a limited extent for the familiar "sandwich" type of construction, fir is the most common one by far. Found in a narrow strip of western Oregon and Washington, the giant trees, which range up to 12 feet in trunk diameter and often have no branches for a height of 100 feet, are the easiest of all wood to "peel," and the resulting sheets are the freest from knots or other irregularities obtainable.

The growth of the fir plywood industry has been phenomenal and has, in fact, topped that of any other forest product during the past half-century. This year 97 mills are expected to turn out more than 4½ billion square feet of the material, which will pass through 1000 warehouses and 27,000 dealers on its way to consumers. The investment in plant equipment is $233 million, and the 31,400 employees earn $154 million annually. Shipments aggregate 101,000 carloads a year and railroad freight bills average $150,000 a day.

The idea of slicing wood into thin sheets originated many centuries ago, but until the 1800's they were used only to veneer thicker pieces. Cases for Egyptian mummies dating from the pre-Christian era and old Chinese furniture were made in this way. Early artisans also may occasionally have laid two thin boards together with their grains at right angles for increased strength, but a method of binding plies commercially was not developed until the 1880's.

The inventors were, of all people, the Russians. Here is a real "first" for them that they have, so far as we know, not claimed. The Encylopedia Britannica, which is our authority for the foregoing credit, does not indicate what kind of wood was initially used.

In this country, cross-laminated boards were utilized sparingly in pianos and perhaps in some other products as early as 1830, but the fir plywood industry didn't come into being until 1905. At that time a small mill at St. John's, Oreg., was started by the Portland Manufacturing Company, which converted the boards into fruit and vegetable baskets. Some of these were displayed in the summer of the same year at the Lewis and Clark World's Fair in Portland. They attracted only meager attention, and newspaper reports alluded to them briefly as a part of an exhibition of "veneers, coffee and spice drums."

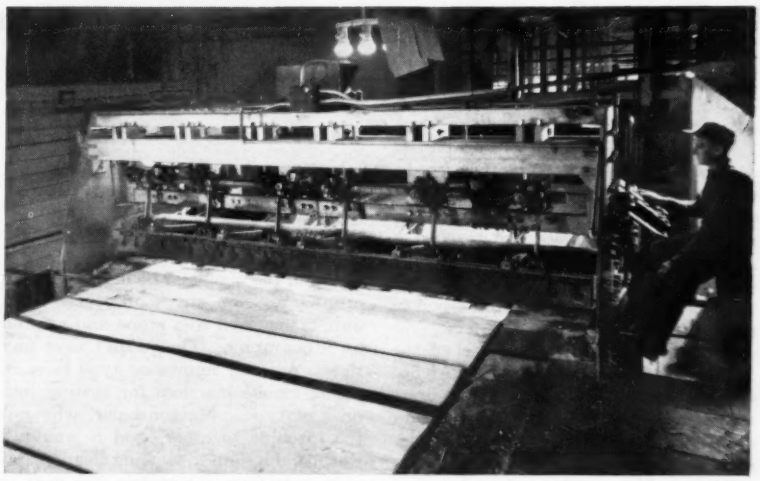
Adoption of the laminated material was slow at first but gained momentum as the industry received better financial backing and the manufacturing methods and product were improved. For fifteen years most of the output went into door panels and bottoms for bureau and desk drawers. By 1908 one plant was turning out 1200 square feet daily for this limited application. Around 1920 automobile manufacturers began to use plywood for car floors and running boards, and this ushered in a real boom. Prior to that time every plywood maker operated a door factory in connection with his plant, and the Elliott Bay Mill Company was the first concern to omit this side line and gamble on selling all its output in the open market. Soon, however, it was joined by numerous others, and in the latter part of the decade some factories ran 24 hours a day on auto stock alone.

The first large concerted promotion effort by the plywood industry was to push its product for use as wallboard by distributing hundreds of thousands of samples. In 1928 plywood was tried out in the building of railroad cars and is now incorporated in 150,000 of them. Another big outlet was created by the construction industry when it adopted plywood as the leading material for making concrete forms. But the product got one

of its greatest upswings when waterproof plywood for outdoor service reached the market in 1934 after the Harbor Plywood Corporation introduced a new type of resinous glue and a hot press for curing it to form a bond that is unaffected by moisture.

This innovation opened up numerous new fields for the material, which was dramatized in 1938 when some plywood boats made a spectacular trip down the Colorado River. In the following year ten million square feet was applied to the outer walls of structures put up for the Golden Gate Exposition in San Francisco, and some of it was taken along by the Byrd Antarctic Expedition for the erection of buildings. During World War II more than five billion square feet of fir plywood went into housing, barracks, shipyards and into military craft. All told, more than 2000 uses for it have been listed, but around 90 percent of it enters into some form of construction. It is estimated that "Do-It-Yourself" craftsmen alone will consume about a half-billion square feet of the board this year.

Two basic types, exterior and interior, are manufactured today. The difference is in the glue, which is water-resistant but not waterproof in the case of the latter. To make certain that specified standards of quality are upheld, the Douglas Fir Plywood Association's supervisors make unannounced visits to the 97 member mills to collect samples at random for testing. A half-million pieces are subjected to rigorous treatment each year. Those of the exterior type are boiled, baked dry, boiled again and then torn apart by mechanical means while they are still wet. Resistance to rupture is recorded, and the separated pieces are closely examined. Unless the glue is stronger than the wood the material does not receive the association's stamp of approval. Other specimens are exposed to year-round temperature and weather on fences on both flanks of the Cascade Mountains. It is the claim of the association that criss-cross construction, by which wood's natural, along-the-grain strength is distributed in both directions, makes plywood, pound for pound, one of the strongest materials known.

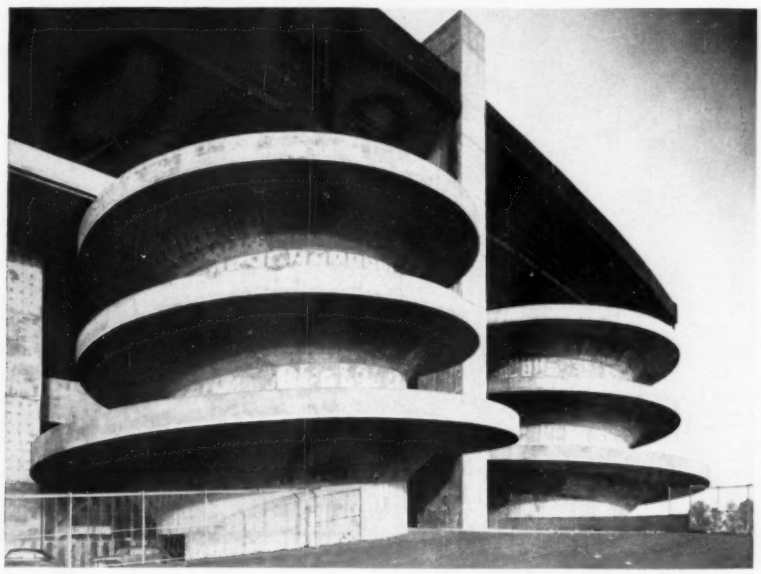


PNEUMATIC GUILLOTINE

As the endless strip of veneer, about ⅛-inch thick, comes off a revolving log it is cut into sheets of standard sizes and defective areas are neatly isolated by a huge air-powered knife. All the operator has to do is punch buttons.

Essentially, the manufacture of plywood consists in peeling thin strips or veneer from logs in giant lathes; cutting the strips into standard-size sheets and drying them; assembling from three to seven plies with the grain of alternate ones running crosswise; applying glue with roller spreaders; and compacting the assemblies into inseparable panels in presses in which high-frequency current sets the glue. The surfaces are then made smooth and imperfections are repaired.

Air power serves at many of the production stages and its use is being widened continually. As logs are carried into the mill from an adjacent pond by conveyor, each is "kicked" off in turn by a mechanical arm extending from a pneumatic cylinder. An air lift generally raises the debarked section to the desired level, when it is gripped by "dogs" in the peeler lathe. As the continuous strip comes off like paper being pulled from a roll, a pneumatic "guillotine" cuts it into sheets. Later, a smaller air-operated knife performs local surgery by cutting out minor imperfections which are replaced with sound pieces of identical shape and size. Often air clamps are helpful in assembling plies into panels, especially small ones, and the pressure that is needed to form the bond (commonly 200 psi) is occasionally applied with compressed air, although most presses are of the hydraulic type. An air ram may be used to push each laminated assembly into and the cured one out of the press at the same time.



SHAPED BY PLYWOOD FORMS

Shown here is a fine example of the adaptability of plywood for concrete form work. It consists of twin spiral ramps, each encircling a 56-foot hollow concrete shaft, with a 90-foot-high column between them. The latter helps to support a 15,000-seat cantilevered steel-frame, double-deck grandstand erected as a $1,500,000 addition to the University of Washington football stadium in Seattle. Plywood of ¼- and ¾-inch thickness was used in making the forms.

The Machine that Broke the Printing Bottleneck

FREMONT KUTNEWSKY

EARLY in the morning of July 3, 1886, a group of men gathered in the composing room of the *New York Tribune* in New York City to watch the demonstration of a machine that was to mark the greatest advance in printing since Gutenberg invented movable type in 1455. While presses had reached a point where they turned out thousands of printed sheets an hour, the setting of type by hand slowed down production to a snail's pace.

Whitelaw Reid, editor-in-chief of the *Tribune*, started the mechanism. An operator played on a keyboard. Slim brass matrices, each with a printing character embedded in its edge, slid from individual channels in a magazine and formed a solid row. Hot metal was forced against them, and out came a bright, silvery "slug" of type ready for the printing forms. Over and over the process was repeated, turning out line after line of type.

The machine broke the bottleneck that had held back progress in printing for 100 years, and soon avalanches of printed matter multiplied human communication, public opinion became a dominant power and the stage was set for today's conception of "one world." The Mergenthaler of 1886, to which Mr. Reid gave the name of "Linotype," was also known as the "blower machine" because the matrices were sent through their channels for casting by means of a blast of air. Today they drop into place by gravity.

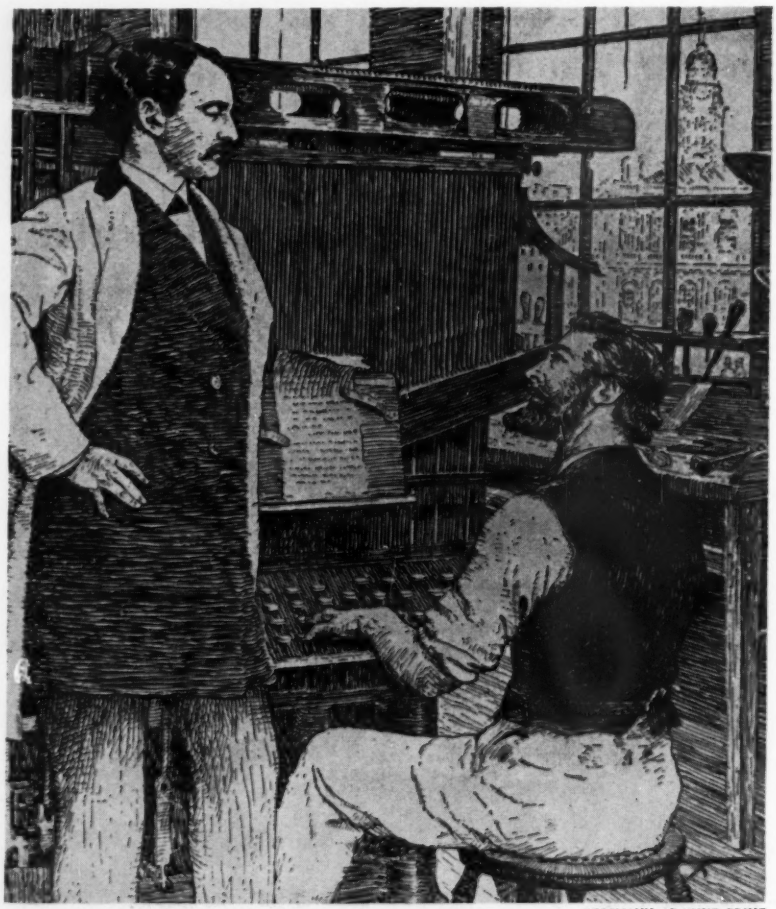
Ever since the industrial age emerged at the end of the revolutionary period of the eighteenth century pressure had been building up for some way to get words into print faster than was possible at the time. Early attempts had gone no farther than the making of machines that would do what compositors did—put foundry type together for printing. Hundreds of inventors, promoters and investors had exhausted their resources in futile efforts to hasten the transition from words to print. Mark Twain, who was a journeyman printer in his youth, was among those who lost fortunes in equipment that didn't work.

After Ottmar Mergenthaler, a young German mechanic of Baltimore, Md., became interested, he solved the two most critical problems: casting type ready to print from matrices that could be used over and over, and devising a system whereby the matrices could be automatically redistributed to their places in the magazine.

James O. Clephane, a court stenographer in Washington, D. C., had been the most persistent advocate of mechanical typesetting. For ten years he had been raising money to produce machine after machine that failed. Clephane was a bouncing enthusiast who could "get blood out of a turnip" when it came to winning the financial support of capitalists. His hopes rose high with every new idea.

One of the machines he backed merely printed lines on strips of paper which were transferred to a stone and printed by lithography. That didn't save any time. Another impressed type faces in papier-maché matrices for casting into lines of type. Mergenthaler, who put the machine together, said it wouldn't work, and it didn't. Getting clean, printable casts from the matrix was next to impossible. Other experiments in which Mergenthaler took part led to similar disappointments.

The machine of 1886 overcame most of the drawbacks, but it had one serious flaw: a good method of automatic spacing that would make all the printed lines of uniform width remained a hope and a bugbear. The shortcoming was surmounted, however, when the Mergenthaler Company bought the United States rights to the Typograph Company, a rival concern. The solution was ingenious. Tapered, wedge-shaped steel bands are dropped like any other letter or punctuation mark between the words formed by the matrices. Just before casting, the machine forces the bands home among the assembled matrices, spreading the line to the desired column measure.



BETTMANN ARCHIVE PRINT

MERGENTHALER'S BLOWER MACHINE

Ottmar Mergenthaler demonstrating the operation of his mechanical typesetter for Whitelaw Reid in the plant of the "New York Tribune." This year marks the seventieth anniversary of the patenting of the machine that helped to pave the way for modern printing miracles. Mr. Reid gave it the name of Linotype, which aptly describes what it produces. In the original model the matrices were transferred by means of compressed air; now they fall into place in the line by gravity and are returned to the overhead magazine by a mechanical conveyor.

A syndicate of newspaper publishers was formed to promote the new machine and the Mergenthaler Linotype Company. Among them were such famous men as Whitelaw Reid; Victor Lawson and Melville Stone of the *Chicago Daily News;* W. N. Haldeman of the *Louisville Courier-Journal;* Henry Smith of the *Chicago Inter Ocean*, and W. H. Rand of Rand McNally & Company. By 1888 sixty Linotypes were in service in plants of syndicate members, and in the following year the *New York Tribune* reported a saving of $80,000 through the faster method of typesetting.

Subsequently, plans were made to move the factory to Chicago, Ill., but Mergenthaler liked it in Baltimore among his German friends and refused to go. As the company didn't feel it should go ahead without him the idea was abandoned. Eventually he left anyway and set up his own small shop. Mergenthaler continued to do contract work for the firm that bore his name and received royalties on machines sold. In all, he and his heirs received $1,500,000. He died of tuberculosis in 1899 after making many improvements in his original machine. Meantime, the Mergenthaler factory was established in Brooklyn, its present location.

Until the development of the Linotype, daily newspapers of four pages were common. Those with eight and sixteen pages were the giants. School children used the same textbooks year after year. Only the well-to-do could afford a library of books in their homes. Magazines were scarce. The Linotype made possible big Sunday newspapers with national circulation and 100-page weekly magazines that go to press on Thursday and reach millions of readers in 48 states on Monday. It was a godsend to printers everywhere because it gave them inexhaustible fountains of fresh type in as many faces for which they might wish to purchase matrices. At first, in order to get the machines into widespread use, the company leased them to printers and publishers. It has always done a great deal of selling on the installment plan.

Other typesetting machines are the Monotype and the Intertype. The latter casts full-line slugs, while the Monotype, as the name infers, sets individual pieces of type. It is, in fact, a miniature type foundry. Fast mechanical typesetting took over the work of the old-time compositor, but for every job it eliminated it created a hundred as printing and publishing leaped ahead like a dammed-up river let loose.

Speed of production has made the printed word the foundation of world-wide literacy and opened the door to universal knowledge and understanding.

International Nickel Adds Research Facilities

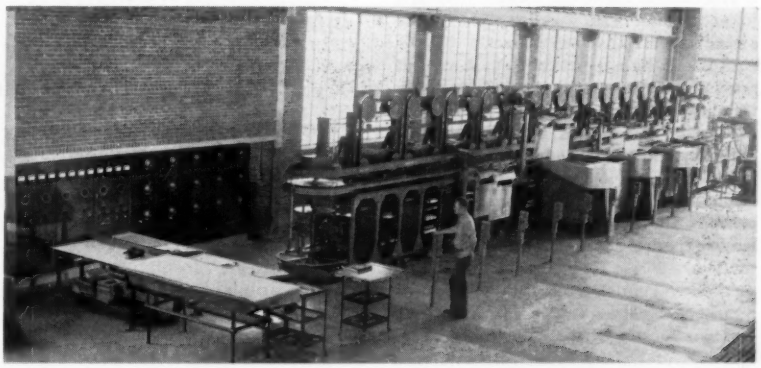
THE International Nickel Company, Inc., has a new pilot plant for the study of plating processes—primarily nickel—which is fully automatic and permits testing new techniques and new coatings under conditions that virtually duplicate those in modern industrial establishments. It is said to be the only facility of its kind. The plant is a part of the company's Bayonne (New Jersey) Research Laboratory and the outgrowth of years of experimental work with plating metals and coatings. The automatic line is capable of turning out plated-metal test panels in large numbers under closely controlled conditions.

A long-standing project that is still in progress, it involves intensive study of the merits of thin nickel-plate for can stock. With major container manufacturers and their suppliers coöperating, the investigations have already produced results that tend to show the superiority of nickel-coated "tin" cans for certain applications. The company points out, however, that it is a long-range program and in many ways dependent on future demands and supplies not only of nickel but also of other plating materials.

Other recent International Nickel Company developments were explained at the time the new plating plant was opened to visitors. One is a multipurpose welding electrode, Inco-Rod "A," which is said to be effective on more than 90 percent of the dissimilar-metal welding jobs encountered in industry. It is especially useful in joining ferritic materials (mild and low alloy steels) to stainless steels, as well as to high-nickel alloys such as Monel and Inconel. Besides producing sound and ductile welds of excellent strength, the corrosion resistance of the deposited metal is superior in most cases to that of the parent metals. The new rod is a nickel-base electrode and is available for test purposes. The firm has also improved an old rod—the "132" electrode—which is used to weld Inconel to itself. It now forms sound welds in the "as received" condition and consumers are no longer required to rebake it to insure the best results.

Another new Inco product is Nionel, a high-nickel alloy that is exceptionally resistant to hot sulphuric-, sulphurous- and phosphoric-acid solutions. It contains about 40 percent of nickel, 21 percent of chromium, approximately 31 percent of iron, 3 percent of molybdenum, 1.75 percent of copper and small amounts of manganese, silicon and carbon. Because of its high nickel-chrome content many oxidizing chemicals have little effect on it.

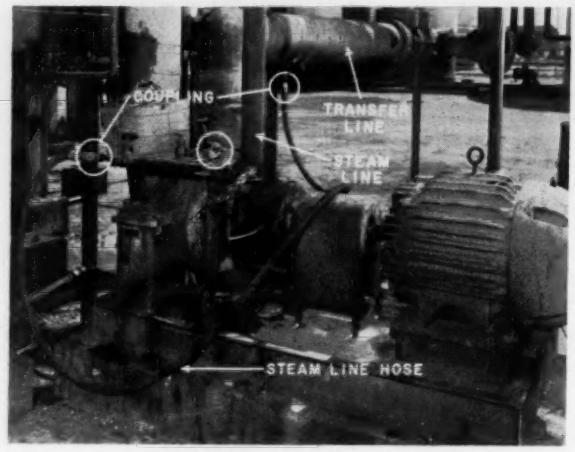
Nionel is expected to find application in equipment for sulphuric-acid pickling baths, refineries, synthetic-detergent plants, rayon manufacturing establishments, ore-beneficiation mills and pulp and paper industries. It has shown good resistance to pitting in salt water and may have many uses in marine equipment and also in heat exchangers using sea water.

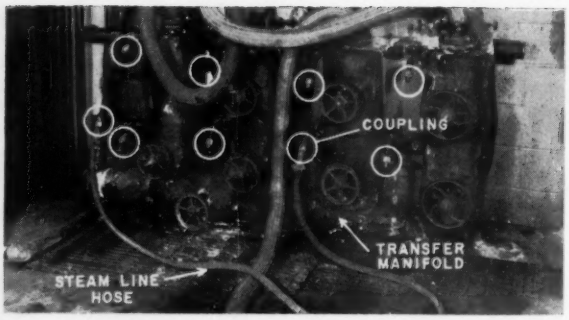


AUTOMATIC PLATING LINE

Test panels up to 3 feet square start out at the lower left and travel through cleaning, plating and washing stations and thence to a drying tunnel. They make a complete circuit and are taken out at the starting point. As shown here, the first three stations are not in use, but additional tanks can easily be put in place. The chain-and-cog mechanisms above and between adjoining stations transfer the plates from one bath to another. Each station and its transfer equipment can be timed to permit a panel to remain in a given bath for any period ranging from a few minutes to hours or even days. All controls for the entire unit are grouped in the panel at the extreme left, although individual stations can be controlled from the posts in the foreground.

Flexible Cleaning System For Chemical Plants





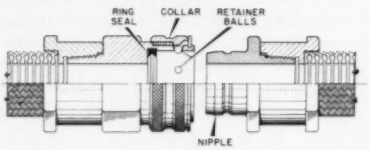
TYPICAL CLEANING ARRANGEMENTS

Two examples of the flexible system for cleaning process equipment at the Neville Chemical Company plant. At the left is an outdoor view showing a transfer line and an Ingersoll-Rand pump that serves it. Steam reaches the area through an insulated pipe and is delivered where needed through a flexible hose which is easily connected and removed by means of Titeflex couplings. The indoor system above has nine admission points (circled in white) fitted with Titeflex nipples that permit quick attachment of the steam line for cleaning. When the job is completed, the latter is disconnected, thus eliminating any possibility of leakage through supposedly closed valves into the equipment during subsequent process runs.

HOUSEKEEPING is a chronic problem that confronts all industry, but nowhere perhaps is the task more difficult than in some chemical plants where equipment handles a variety of sticky, viscous liquids and must be cleaned. Many of the operations are on a batch basis, and with much of the piping and other facilities being used for several different processes it is necessary, to avoid contaminating subsequent runs, to clean all of it thoroughly after each batch. Compressed air or high-pressure steam, in combination with certain solvents, has long served the purpose admirably, and so far nothing better or less expensive has been found.

Heretofore, however, there has been a joker in the deck. In many places the air or steam is piped directly to the equipment by a permanent system and admitted to the various parts simply by turning valves. Offhand, this would seem to be the easiest and most economical method, but because of certain factors it is considered by many to be undesirable. Should a valve be left open inadvertently or leak, the next batch might be hopelessly spoiled with perhaps a heavy monetary loss. Then, too, many of the vessels and much of the piping are outdoors, and valves have been known to freeze in winter between cleanings. And the cost of a fixed system often comes high, especially in plants where operations are extensive.

Neville Chemical Company, of Pittsburgh, Pa., has solved the problem by using flexible hose and unique couplings in place of much of the permanent piping. Now only two such lines—one for air and one for steam—serve each process area. Each pipe is dead-ended in a manifold fitted with a coupling made by Titeflex, Inc., of Springfield, Mass. When a piece of equipment or a transfer line is to be cleaned, a hose is quickly snapped onto the air or steam pipe and then attached, through a similar coupling, to the dirty equipment. When the work is finished (it takes about 10 or 15 minutes) the hose is removed, thus ending any danger of air or steam leaking into a subsequent run. Moreover, the absence of long stretches of uninsulated outdoor piping automatically obviates cold-weather operating difficulties. Appreciable savings have been made in the cost of the basic installation by eliminating considerable piping and numerous valves.



DETAILS OF HOSE COUPLING

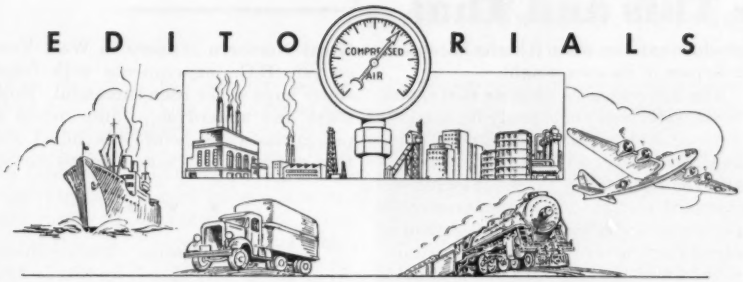
Titeflex couplings are claimed to be leakproof at high pressure, can be connected or disconnected with only one hand and are full swiveling to prevent kinking and twisting of the hose lines. Furthermore, it is possible to change the pressure seals easily without dismantling the coupling—an advantage in this case because the steam (at pressures of from 75 to 150 psi) and some of the solvents used attack the seal material.

Air Helps Simplify Insulator Maintenance

IN COMPRESSED AIR and finely ground calcite Illinois Power Company has found the answer to a problem that formerly gave the maintenance men a lot of trouble. In the past, it was a mean and time-consuming job to clean transmission-line insulators, especially at a soybean-plant substation. There the parts soon became covered with dust that turned into a sticky mass when moist and caused many service interruptions through flashovers. It took from six to eight men approximately seven hours to clean the insulators, but even so replacements had to be made frequently.

Calcite-blast or "hot-stick" cleaning, as it is termed by Illinois Power, is nothing more nor less than a spray method that has so far proved most effective with air at 125 psi pressure to apply the powdered mineral. When first tried at the soybean plant, the accumulation was easily removed by three men in about two hours. The same result, without visible injury to the insulators, was obtained at the substation of a plating establishment where the deposit was so hard that steel wool and cleaning compounds had no effect on it.

There are still a few bugs in the system that have to be overcome. For one thing, when the humidity is high, the spray unit becomes clogged after a few hours' use and must be dismantled and cleaned. But from the standpoint of service rendered, the method is highly satisfactory. It has eliminated frequent interruptions caused by insulator flashovers, insulators do not have to be replaced periodically and cleaning time has been reduced as much as 85 percent.



MAINTENANCE ON THE RISE

WHEN muscles were the principal source of industrial power, machinery maintenance wasn't much of a problem, but as mechanization has grown so has maintenance. It is already important, and predictions are made that it will become doubly so during the next ten years.

Some authorities believe that we are in the midst of what they term the second industrial revolution—the change from simple mechanization to automation. If the prevailing trend continues, it is certain that production workers will decline and maintenance workers will increase. Already there are numerous single plants (two cited at random are an oil refinery and an aircraft factory) that have more than 350 maintenance employes each. The annual national bill for keeping industrial plants functioning efficiently is estimated at $14 billion, a sum that equals the value of all our imports. It is double the total of fifteen years ago, and some say that it will double again within the next ten years.

By 1960, we are told, our labor force will have acquired from seven to ten million more workers, but a continually growing percentage of the newcomers will most likely go into maintenance instead of production. It is a fair assumption that many technical schools will soon be teaching maintenance engineering, and that large industrial companies will establish training courses in maintenance for graduate employes, such as they now conduct for production men and salesmen.

Already well started is a movement to devise well-ordered, time-saving techniques and efficient equipment for speeding maintenance operations. The aim is to set up systems that will make sure that production machines will be serviced before they break down. This expanding field includes many concerns—is, in fact, big enough to support exhibitions of tools and methods now available for maintenance work. The East has been witnessing these shows for several years, and in 1954 the first one to serve the West was staged in California. It was so successful and filled such a need that it will be made an annual affair, with the next exposition scheduled for Los Angeles in July.

Prominent in the displays will be electronic data-processing machines for storing and producing quickly when wanted information that has heretofore been going into standard files that give it up only at the expense of considerable time and effort. There will also be systems and equipment that will automatically keep tabs on production machines and reveal when they need attention. Included will be an ultrasonic unit that readily finds hidden defects in metal that the eye can't see.

Another potent preventive maintenance tool is automatic lubrication. Lubricants have been called the life blood of today's continuous production line, and many large plants have sizable staffs of lubrication engineers to handle requirements. Likewise on view will be plant housekeeping aids such as rust- and corrosion-resisting paints and compounds, nontoxic cleaning solvents, vacuum cleaners and blowers to rout dust, safe and effective scaffolding of varying types and kits of tools that are designed to perform many maintenance jobs in the quickest possible time.

THE MAN HUNT

WE HAVE had gold rushes and uranium rushes and now we are experiencing a rousing man rush. The object of the search is a particular type of man, usually around 21 years old and just finishing college. Although he probably never held a steady job, he is valuable because in our fast-moving supersonic-automatic-electronic-atomic era trained technical brains are a treasure more desired by industrial concerns than any precious metal.

With the school year nearing an end, hundreds of firms, big and little, have ears bent toward the campuses of engineering colleges from coast to coast. Throughout the year their intellectual prospectors have been roaming the field trying to stake claims on members of the class of '55. Now is the fateful time when the graduates—kings of all they survey—will make known where they have elected to go to work. Even the largest and most powerful corporations can only wait until youth has spoken.

From Columbia University, which may be considered a fairly typical example, comes word that every record for recruiting its senior engineers has been broken. All told, 260 company representatives sought interviews with the 200 young men who will receive B.S., M.S. and doctoral degrees this year. One hundred other concerns sent application blanks and promotional literature to the placement bureau in the hope that some of the budding graduates might ask for jobs. Probably few of them will be enticed by such tactics, because the competition is too keen. Virtually all the talent seekers want more than one man, and three or four of the larger ones could each find places for the entire class.

According to Columbia's associate dean, Wesley J. Hennessy, American industry has indicated that it will need 30,000 engineering graduates annually for a good many years to come. But only 21,500 diplomas will be handed out this June by the nation's engineering schools. Because of the scarcity of engineering brains, the price has gone up. Average starting salaries offered Columbia's seniors have risen between five and ten percent during the past year, and almost 50 percent since 1949. Most wanted are electrical and electronic engineers, with chemical and mechanical majors next. Aircraft manufacturers lead the list of would-be hirers, followed by chemical and electronic concerns. Oil companies also are strong bidders.

The pressure on the seniors at Columbia started in February, two months ahead of the usual time. The school placement bureau didn't have enough room to accommodate all the interviewers, and some of them had the boys come to their hotels. Many concerns sought not only seniors but also underclassmen for summer work on a tryout basis. Although this employment does not obligate the boys, experience shows that about half of them take jobs with the same companies after graduation.

The demand for industrial engineers is heightened by the fact that our country is becoming a considerable exporter of engineering talent. We now utilize 40 percent of the world's inanimate energy and account for 40 percent of all industrial and manufacturing output. Our governmental policy of helping backward nations improve their economies necessitates sending them trained engineers to design, build and start up factories and to train operating staffs.

This and That

Facts About "Forrestal"

Uncle Sam's new $200-million, 60,000-ton super airplane carrier, the U.S.S. *Forrestal*, utilizes 200,000 hp—enough to furnish electricity for a city of 1½ million people. It is 1036 feet long, can make 30 knots and will carry a crew, including the air group, of 3500. Eighty-eight soot blowers are used to clean its eight boilers. Steam is the blowing medium, and the units are automatically moved back and forth at regular intervals by air-powered motors.

★ ★ ★

Sea-Water Ice Keeps Fish Fresh

Fish caught at sea may soon be preserved on board ship with chilled salt water or with ice made from it. In either case, there is the promise that seafood will keep longer and better than it now does when kept cold with fresh-water ice. Experiments are in progress on the east coast with a newly invented machine for freezing salt water, and on the west coast tests are being conducted with chilled sea water.

It is estimated that under current icing methods at least 25 percent of the potential revenue and profit of commercial fishing are lost. This is so because it is impossible to forecast when fish will be taken and, therefore, to estimate accurately how much ice to take on a fishing expedition. A ship may get a good haul after several days of searching and have to return to port before being fully loaded because the ice supply is running low. This uncertainty often keeps trawlers from attempting to fish the more distant banks.

Fresh-water ice melts at 32° to 33°F and keeps fish at from 36° to 38°. Ice from sea water with a salt content of 3 percent melts at from 28° to 29°F and keeps fish at from 32° to 34° but does not freeze them. By increasing the salinity of the water from which the ice is made to around 10 or 12 percent, the melting point can be lowered to approximately 22° to 24°. This retards enzymic action, which is chiefly responsible for deterioration. Consequently, with salt-water ice available, fishing fleets could go farther from port, stay away longer and land catches or bring back fresher fish.

Repeated tests have shown that fish stored for three weeks in salt-water ice are preferable to those held for from seven to ten days in that from fresh water. When so packed, the ice immediately above and around the fish often melts, thus creating air pockets that permit dehydration of the flesh and oxidation of the oils that causes rancidity, materially lowering the quality. Ice from salt water, on the other hand, does not produce cavities when it melts because it collapses of its own weight.

The salt-water ice machine that is now being tested and made ready for marketing was invented by a man named Taylor and turned over to The Cooley Associates Inc., of Boston, Mass. It includes a standard electric-driven compressor to pressurize the refrigerant, but instead of expanding the refrigerant in conventional coils, that is being done in one or more flattened hollow plates. It is this heat-absorbing element that needs additional attention and refinement before units are offered for sale. It is estimated that a machine big enough for the average trawler will cost less than $15,000 and that this sum will be recovered in 18 to 24 months by eliminating the purchase of ice. Crushed fresh-water ice, delivered to New England boats, costs about $6 per ton.

The use of refrigerated sea water rather than ice is being tried on trollers in British Columbia waters, and limited tests were made previously by Libby, McNeil & Libby in Alaska and also by shrimp fishermen in Louisiana. In British Columbia, the fish are placed directly in the water in metal-lined tanks, and in some cases have been held for ten or more days without deterioration. The fish look better than those preserved in ice because water does not exert a crushing effect on them.

The tanks so far used carry from 700 to 2500 pounds of fish, although experiments will be made with units having a maximum capacity of 40,000 pounds. Research conducted at the Pacific Fisheries Experimental Station indicates that a 1-hp compressor is adequate for a 3000-pound holder. It will cool the initial charge of sea water from 50° to 30°F in about ten hours and maintain the temperature without difficulty.

Chilled salt water is also being tested for service in canneries where fish stored overnight or week-ends often creates a problem because many of the plants have no ice-making equipment. At the Great Northern cannery in West Vancouver, B.C., experiments with frigid water have so far been successful. Both there and aboard ship, aureomycin is put in the water before it is chilled, and that seems to help keep the fish fresh.

★ ★ ★

New Dyeing Process

Ultrasonic vibration markedly speeds up textile dyeing and other wet treatments of synthetic fibers, according to Acoustica Associates, Inc., of New York. Recent work with cellulose, rayon and other materials indicates that level and complete dye penetration can be obtained at less than boiling temperature in as little as one-sixth the time required by the conventional high-temperature process. Especially favorable results have been obtained with the hard-to-dye material Orlon. In operation, swatches or skeins are lowered into a dye-filled jar on the ultrasonic generating equipment. The jar is secured to a magnetostriction-type transducer that develops vibrations at a frequency just beyond hearing range.

The vibrations set up intensive cavitation in the liquid. Millions of vapor bubbles are created and collapsed continually. Their collapse releases tremendous pressures, equal in the aggregate to thousands of G's, which break up agglomerates in the dyestuffs and produce very fine, uniform dispersions. The dye penetrates the fabric with terrific force but without any mechanical effect on the fibers, yarn, or cloth weave. Other applications in the textile field include rinsing, scouring, bleaching, fulling, resin impregnation, mercerizing and other wet-finishing operations. The generator may also be used for degreasing and cleaning metal, glass and plastic pieces.

★ ★ ★

Rays Save Food

Cold sterilization of foods by irradiation with high-intensity gamma rays has received considerable attention lately from major producers as well as governmental agencies and research laboratories. Although some foods lend themselves admirably to the process (irradiated potatoes will keep up to eighteen months without sprouting or turning soft), others undergo a slight flavor change that makes them unacceptable. Now some research scientists are of the opinion that this can be prevented by irradiating them while in the frozen state and while under high vacuum or in the presence of inert gases. They say that foods so treated may appear on grocers' shelves in about ten years. Expectations are that they will keep at room temperature for at least several months.

Industrial Notes

For industrial holding applications which call for both high strength and adhesion with freedom from sticky deposits, Behr-Manning, a division of Norton Company, is manufacturing a new paper tape that is said to have a minimum tensile strength of 45 pounds. This desirable property is obtained by a backing of 4-mil rope stock and an adhesive strength of 65 ounces per inch of width. Elongation is 5 percent. Designated as No. 131 Behr-cat, the product withstands temperatures up to 250°F. It is 8 mils thick and supplied in ¼- to 3-inch widths in 60-yard rolls. Wider stock is made to order.

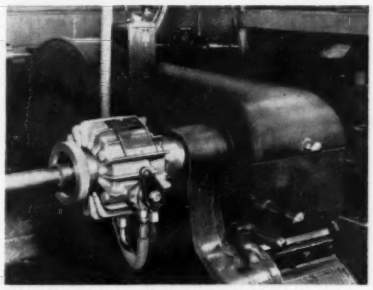
Circle 1E on reply card

Sealing bands crimped tight on the caps of containers are insurance against tampering and contamination of the contents after the packages leave the factory. Bands of this type are manufactured by Upressit Products Corporation, which has recently introduced two crimping tools of improved design and lighter weight than the earlier models. One is hand- and the other air-powered to meet the needs of small- and large-

scale packagers. The former has a lever which the operator squeezes to effect closure, while the other is attached to a shop air line and actuated by slight pressure on a trigger. In either case, the sealing member is inserted in a recess in the tool, which is then fitted over the cap. To open the container the band is ripped off, leaving the cap which insures a leakproof seal no matter how often it is snapped off and on. Both crimping tools are made in sizes to accommodate standard Upressit closures for openings ranging from 26 up to 73 mm in diameter.

Circle 2E on reply card

As a substitute for hand levers and wheels, Wilson Air Collet Closer, Inc., has designed an improved pneumatic device for opening and closing collets on engine and turret lathes handling 1-inch bar stock. The unit operates on the principle of an innertube inflated with air and is foot or fingertip controlled. The load is carried by two thrust and



radial bearings and the heat generated is dissipated through fins. Being oil-resistant, the closer needs no rings, pistons, or packing and is said to prevent work slippage with incidental damage to delicate parts and to adjust itself automatically to variations in stock size.

Circle 3E on reply card

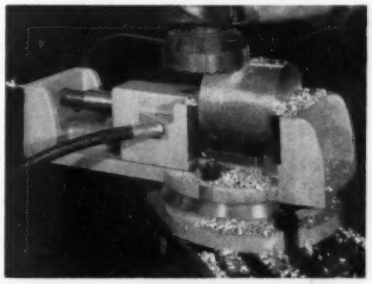
After extensive laboratory and field tests, the Globe Chemical Company of Cincinnati, Ohio, has changed over from metal to plastic piping for the distribution of highly corrosive acids throughout its plant. Made of polyvinyl chloride, the piping ranges from 1¼ through 2 inches in diameter and has unplasticized injection-molded screwed fittings produced by Tube Turns Plastics, Inc.

Circle 4E on reply card

The term roof bolting has been superseded by rock bolting because the method is now used to pin not only roofs in place in mines but also loose slabs to vertical and inclined faces, to sides of shafts and even to toes of cliffs to prevent them from falling.

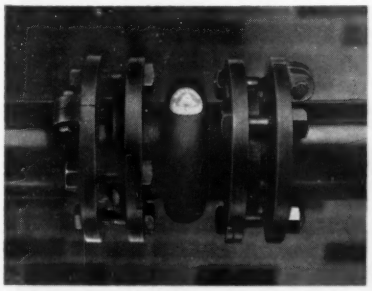
Paper that is said to be three to ten times stronger than that made from conventional pulp or rags is being produced for the first time from nylon, dacron-polyester and orlon-acrylic fibers—that is, synthetic fibers. A Du Pont achievement, it is still in the experimental stage.

A new vise that may be used either as the base of an automatic machining fixture or operated manually between production jobs has been announced by Wilton Tool Mfg. Co., Inc. A hydraulic unit with compressed air serving as the motivating medium, it exerts a locking



force of 9040 psi with air at 100 psi at the touch of a control lever. The air-hydraulic booster cylinder is connected to the vise by a flexible hose and may be

Special expansion joints for use with piping and flanges manufactured by The Duriron Company, Inc., and Haveg Corporation have been announced by The Garlock Packing Company. They are made of a high-grade rubber compound combined with plies of sturdy cotton duck and reinforced with steel wire. Incorporated in the flange ends are steel rings to permit tightening the connections without shearing the joints. Known as Garlock 209, they are avail-

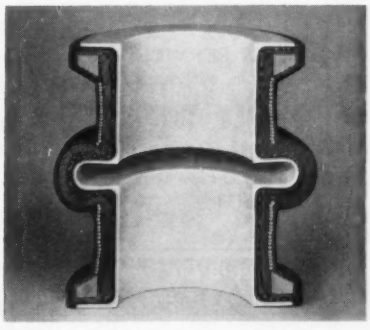


INSTALLATION VIEW

Haveg Corporation pipe with expansion joint in position. The other view shows a half section of a joint with a Teflon liner.

able with a neoprene lining if there is some oil in the line; with a neoprene coating and lining if the outside of the pipe is also in contact with oil; of neoprene throughout for service with petroleum derivatives; and with a Teflon liner if liquids or gases harmful to rubber are carried. The expansion joints are supplied for pipe sizes from 1 inch through 12 inches and compensate for linear expansion and contraction of the line, absorb vibration and reduce and sometimes eliminate noise.

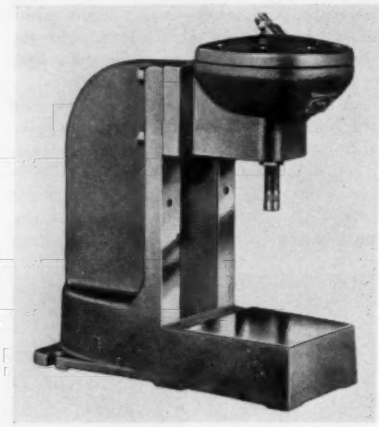
Circle 5E on reply card



mounted on the floor or the machine. Named Milomatic, the unit is available in two models (stationary flanged base or graduated swivel base, as pictured) with a 6-inch jaw width and 6¼-inch opening, maximum.

Circle 6E on reply card

Air Press Model 80 introduced by W. R. Brown Corporation is of sturdy construction and designed for rapid action. Of 1-ton capacity, it has a dia-



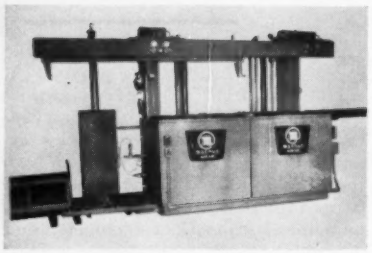
phragm-actuated ram with powerful spring return and is said to multiply the operating line pressure up to fifteen times. Air at 50 to 150 psi is used. Ram clearance ranges from 0 to 5 inches, stroke is ⅝ inch, and the positions of both the ram head and plunger are adjustable. The press is suitable for such operations as punching, stamping, stapling, crimping, assembling, clamping and bending.

Circle 7E on reply card

Both to protect the threads of gas-cylinder valve outlets from damage and keep the openings clean during handling, shipping and storage, S. S. White Plastics Division has designed a cap that jarring will not loosen, it is claimed. Made of flexible nonshredding vinyl plastic, it is held in place by friction and suction and is provided with a tab that easily breaks the grip when pulled. Two sizes for 0.825- and 0.903-inch (outside diameter) threaded outlets are available.

Circle 8E on reply card

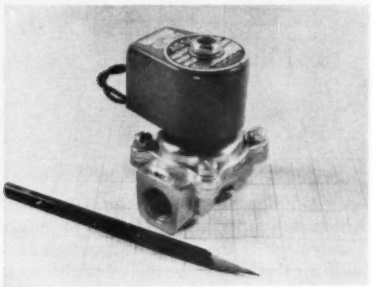
Air-lift loading and a Nu-matic push device are features of an improved type in a line of Aja Lif Automatic cleaning machines developed by Magnus Chemical Company. The work to be processed is usually placed in baskets which are shoved successively onto a roller platform that rises to the top of the equipment (the one illustrated has two tanks). Simultaneously, similar rollers, one in each tank, are lifted to the same level.



Next the air-powered pusher transfers each load one step forward in the series of operations. The action of the drive and lift are synchronized by a timer so that the platforms in the cleaning bath are lowered, vigorously agitated by mechanical means and raised, all within a predetermined period. After that the work advances one more step and the cycle repeats itself until the machine is shut off. The unit is suitable for installation in production lines, can be designed for any number of functions and used with solvents, alkalies or acids.

Circle 9E on reply card

Automatic Switch Company has announced a new packless solenoid valve for low-pressure application up to 7 psi. Designed primarily as a gas (manufactured and natural) pilot control on power boilers, it can be used with ovens and furnaces, automatic dispensers, vacuum-holding and other equipment to regulate air, propane, butane, gasoline, light fuel oil, water, etc., at temperatures up to



180°F. Of the normally closed type, the stainless-steel core with firmly attached composition disk, the only moving element, is lifted directly off the seat when the valve is energized and tightly closed by a spring when deënergized. The Model 8030A is available in ⅜- and ½-inch sizes and also with an explosion-proof solenoid enclosure approved by Underwriters Laboratories.

Circle 10E on reply card

By a new process developed by Alloy Surfaces Company, ferrous metals, including grey- and malleable-iron castings, are given properties that put them in the same category as stainless steel. This is achieved by chromium, which is diffused in the metal to depths of from 0.001 to 0.008 inch without causing di-

NON-FLUID OIL
TRADE MARK REGISTERED

A SPECIFIC LUBRICANT FOR PNEUMATIC TOOLS!

Special Grades of NON-FLUID OIL - - - manufactured especially for all pneumatic tools and compressed air equipment - - - give better lubrication and automatic protection against rusting and sticking, regardless of moisture content of your air.

Used successfully by largest operators of air tools and approved by all leading manufacturers of tools.

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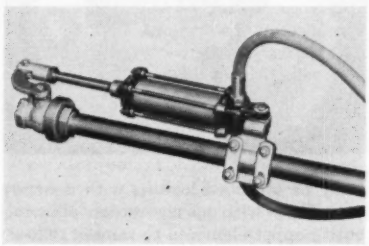
NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

Circle 15A on reply card

mensional changes. According to the manufacturer, metals or parts so processed resist not only corrosion under the most severe atmospheric and chemical conditions but also thermal oxidation at temperatures up to 1700°F, and the surface will not chip, crack, peel or gall when the metal is bent 180°, stretched or twisted. Products can be brazed and welded before or after treatment.

Circle 11E on reply card

Among the features claimed for a new Rockwood ball valve are: leakproof service, full flow, quick opening and closing and no maintenance. The unit is air powered and designed for remote-control use, permitting scattered valves to be operated from a switchboard. This is



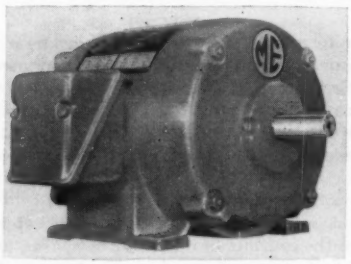
especially desirable where valves are located in hazardous areas. It comes in sizes ranging from ⅜ inch to 2 inches, and kits are available by which conventional Rockwood ball valves can be converted to air operation.

Circle 12E on reply card

A new type of compressed-air filter for the removal of particles in the micron and submicron range has been announced by Perry Equipment Corporation. It is provided with replaceable glass-filter elements that can be used for long periods it is claimed without attention and little loss in pressure. The separator can be obtained with an integral mist eliminator by which fine particles are coalesced for removal.

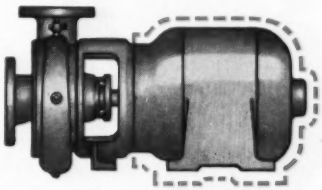
Circle 13E on reply card

Four-in-one protection is built into Marathon Electric Manufacturing Corporation's new electric motor designed to meet modern industrial needs. Available in 3- and single-phase ratings, the unit has a cast-iron frame with screened openings and reinforced, milled feet for

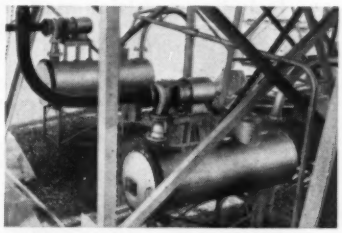


Q.E.D. ...which was to be demonstrated

Quality of Ingersoll-Rand Motorpumps is evidenced in the extra-heavy, extra compact design and construction shown above. From suction to discharge a Motorpump is built to the highest standards that can be established.



Efficiency is shown by smaller motor hp required to drive the I-R Motorpump. The impeller is precision balanced for peak performance. Design permits short shaft to eliminate deflection and whip. From packing to pump-casing, parts are engineered to make a smooth operating machine that delivers the goods—on every job.



Durability is proved by the illustration above. These I-R Motorpumps were installed 4 years ago and paid for themselves in the first 90 days of service. Service is both rugged and continuous, yet, in all this time, there has been no maintenance downtime.

MOTOR PUMP

Write:

Ingersoll-Rand

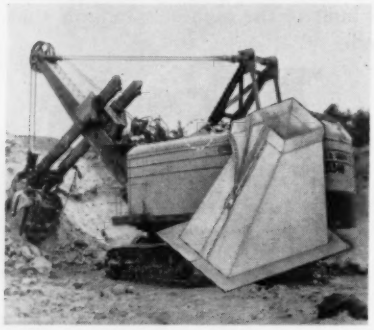
9-220 11 Broadway, New York 4, N. Y.

Circle 16A on reply card

overhead, side-wall or standard floor mounting; a heat-treated, corrosion-inhibited rotor skewed for quiet operation; and an internally ground stator to insure perfect shaft alignment. Vinyl-acetal resin on all conductors and mylar phase separators with high mechanical dielectric strength provide maximum resistance to moisture. The winding is impregnated with silicone-treated varnish. In addition to the drip-proof, splash-proof, weather protected and guarded type, the line includes a totally enclosed, fan-cooled motor.

Circle 14E on reply card

Sometime ago A&A Manufacturing Company, Inc., announced that it had gone into the business of producing zippered sleeves and boots to keep lubricants in and dirt out of machinery operating indoors. The line has now been extended to include outdoor equipment or parts of machines to protect them against the weather. The accompanying illustration shows a zip-on boot that was designed to make an opening in the cab of a power shovel water-tight so as to prevent the occurrence of electrical hazards. The covers are manufactured to order.



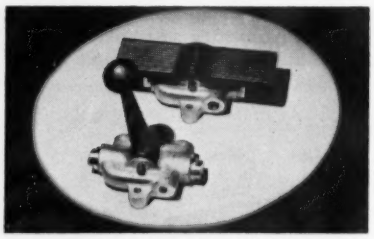
Circle 15E on reply card

Sounds like a simple gadget, but it has doubled the life of doors in the offices and plants of the concern that conceived it. Instead of pushing wedges under them (and wedges have a habit of going astray), the Carboloy Department of General Electric Company, Detroit, Mich., uses a holder consisting of a horseshoe magnet and an aluminum bracket fastened to the floor or wall. On wooden doors it is necessary, of course, to nail a metal plate. The idea was born when the maintenance man's figures revealed that the average plant door lasted about five years.

In answer to the need for a solvent to remove neoprene compounds from parts protected with such coatings at the factory to prevent damage before use, Ansul Chemical Company has come up with an ether that is said to do the job quickly and effectively. In the case of Radomes, for example, Plexiglas shrouds for airplane radar equipment, it now takes a man half an hour to clean one—work that formerly required eight man-hours. He merely makes a paste with Ether 181 and applies it. After a lapse of two hours the mixture, together with the neoprene compound, literally falls off.

Circle 16E on reply card

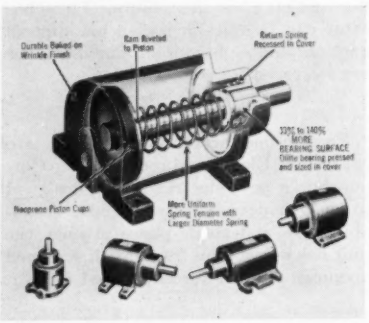
Airmatic Valve, Inc., is marketing a new hand- or foot-operated 3-way valve of the Venturi type for air, oil or water pressure from 0 to 200 psi. It can be furnished either locking or nonlocking



(may be obtained locking with neutral) as well as with spring return allowing both poppet elements to remain seated. All nonlocking models are available with spring return for "on" or "off" position. For use with ¼-inch pipe (inside diameter), the Model HF-3 has a full-flow capacity of 50 cfm at 50 psi and is recommended for small single-acting cylinders.

Circle 17E on reply card

By completely redesigning its line of single-acting Air-Clamp cylinders, Mead Specialties Company has improved these economical units without adding to their length. Among the advantages claimed for the new type are a steadier ram through increased bearing surfaces, more


Durnite Baked on Wrinkle Finish
Ram Bored to Piston
Return Spring Recessed in Cover
320% to 140% MORE BEARING SURFACE Oilite bearing pressed and sized in cover
Neoprene Piston Cups
More Uniform Spring Tension with Larger Diameter Spring

uniform tension because of a larger-diameter return spring, less wear by use of replaceable Oilite bearings, and greater efficiency and service life. A total of 26 models varying in bore, capacity and mounting is carried in stock.

Circle 18E on reply card

A reciprocating air-hydraulic booster for the continuous operation of hydraulic cylinders requiring large volumes of

Lehigh INC.

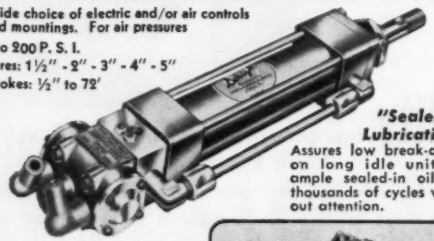
A COMPLETE LINE OF AIR CONTROL EQUIPMENT

Including precision-made HEAVY-DUTY

AIR MOTORS

WITH "SEALED-IN LUBRICATION" Pat. Pend.

Wide choice of electric and/or air controls and mountings. For air pressures 5 to 200 P. S. I.
Bores: 1½" - 2" - 3" - 4" - 5"
Strokes: ½" to 72'

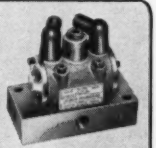


"Sealed-in Lubrication" Assures low break-away on long idle units — ample sealed-in oil for thousands of cycles without attention.

"Sealed-in Lubrication"

AIR CYLINDERS 1½" to 8" bore

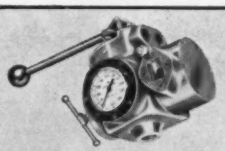
3 or 4-Way AIR POWERED VALVES



Air or electrically operated. J.I.C. Standards.

You Are Invited To Consult Our Engineering Department freely on all air automation or replacement problems. Trained factory personnel available nationally.

Write for Catalogs and Name of Nearest Lehigh Representative



COMBINATION VALVES Panel units, hand and foot operated valves. Wide range of models.

Lehigh Minor AIR VALVES and CYLINDERS

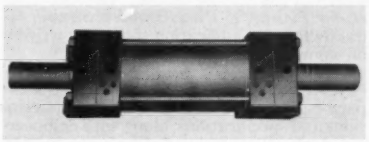
Low priced, light duty. For air operated jigs, fixtures, high speed operations.

Lehigh INC.

ENGINEERS & MANUFACTURERS
1513 Lehigh Drive
EASTON, PENNA.

Circle 17A on reply card

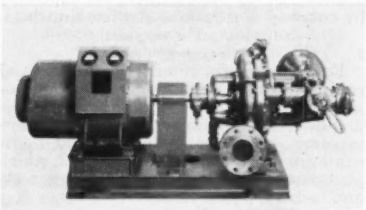
high-pressure fluid has been announced by Miller Fluid Power Company. The unit consists of a pneumatic cylinder with a piston terminating at each end in a hydraulic discharge-pressure chamber.



At the end of each stroke the piston assembly comes in contact with a button inside of the cylinder. This causes an actuator to shift a 4-way, 2-position valve, thus reversing the air flow and delivering a pressure-output stroke in that direction, and so on back and forth. The manufacturer believes this to be the first heavy-duty booster of its kind in a double-acting model. It is available in ratios to give pressures of 10,000 psi and more, but at present is stocked in sizes with a hydraulic output of 2000 psi from 80 psi air input. The unit is recommended for work requiring high holding pressure without generating heat and consuming power.

Circle 19E on reply card

For emergency lighting or where dependable power is required for various purposes, Coppus Engineering Corporation is offering a line of packaged a-c single- and 3-phase turbogenerator sets. Mounted on a structural-steel base, they are ready for installation and do not need a switchboard. The units consist of a Coppus Type TF steam turbine with a constant-speed governor, excess-speed



safety trip, sentinel relief valve and steam strainer and are connected by a Falk flexible coupling to an Electric Machinery Manufacturing Company packaged generator. They are available in ratings from 3.75 to 62.5 kva.

Circle 20E on reply card

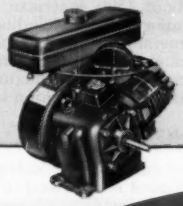
For use in open-pit mines that require a maximum climb of 820 feet to surface level, Soviet engineers are claimed to have built a self-propelled electric rail truck with a carrying capacity of 60 tons. The vehicle can negotiate grades of twice the normal steepness without difficulty, it is reported, and is equipped with two compressors to dump the load in either direction. Power is picked up from contact rail along the track.

Ingersoll-Rand GYRO-FLO 105 Compressor supplying air for paving breaker cutting off concrete piling to set bridge. Power, Continental Red Seal.

means Dependable Power

In addition to its large engines, Continental builds an outstanding line of heavy-duty air-cooled four-cycle models for industrial applications requiring 2 to 3 h.p. (AU series illustrated). Advanced engineering gives them easy starting, high dependability, and unusual lugging capacity at low speeds . . .

Options: patented and exclusive Contex® external ignition system, low-level ignition cut-off, 6-1 reduction gear, and other features. Available also for use on kerosene . . . For information on these models, address Air-Cooled Industrial Engine Division, 12800 Kercheval Ave., Detroit 15, Mich.



All through the construction industry, you find Continental Red Seal engines accomplishing two important things. One is furnishing power to do the world's work; the other, building prestige for specific makes of equipment. The Red Seal line includes models engineered to a wide range of building applications, and meeting those needs completely . . . turning more and more users of mixers, pumps, compressors and other specialized machinery to makes which feature this extra-dependable power.

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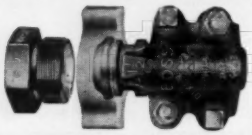
1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GA.

Circle 18A on reply card

"GJ-BOSS"

GROUND JOINT, STYLE X-34

HOSE COUPLING



The female-type coupling you can rely on for tight, safe connections on the big drills; manifolds; jumbos; in caisson work; and all other high-pressure operations. Copper insert in spud fits rounded head of stem, forming soft-to-hard, leakproof metal seal. "Boss" Offset Interlocking Clamp provides powerful grip on the hose—proof against blow-offs. Also available in washer type, and with companion male coupling. Sizes ¼" to 6".

"BOSS" HOSE MENDER

STYLE BM-16

The practical, safe way to quickly restore damaged hose to service. Complete fitting consists of mender tube and two "Boss" Interlocking Clamps. Tube has flanges to engage clamp fingers. Tube shanks have well-defined, smooth corrugations. Thoroughly rustproofed. Sizes ½" to 6".

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Circle 19A on reply card

Books and Industrial Literature

Turboblowers, a new book by Dr. A.J. Stepanoff, treats the theory, design and application of centrifugal and axial-flow compressors and fans. The 377-page volume offers a balanced picture of past and current work in the field and also explains a number of new methods and techniques. The author's axial-flow compressor-design method is based on actual fluid deflection and observed pressure and capacity coefficients rather than on lift and drag coefficients (part of the air-foil theory, which is discussed sufficiently to demonstrate its limitations and weaknesses).

Doctor Stepanoff presents a theoretical treatment of compressor impellers based on a single-flow pattern and extends the treatment to design procedure for both centrifugal and axial-flow impellers. Another chapter stresses the hydrodynamic nature of pressure generation in contrast to the indirect thermodynamic basis previously accepted. Still another section is devoted to water-cooled compressors and incorporates detailed numerical examples and complete energy-balance data.

Doctor Stepanoff is a member of the A.S.M.E. (was the 1932 Melville medalist), has been a designer and development engineer with Ingersoll-Rand Company since 1940, has published numerous articles on turbo-machines and is the author of *Centrifugal and Axial Flow Pumps* (Wiley, 1948). *Turboblowers* is published by John Wiley & Sons, 440 Fourth Avenue, New York 16, N.Y., and is also available through Compressed Air Magazine Publishing Company, 942 Memorial Parkway, Phillipsburg, N. J. Price, $8.00.

Pipe Friction Manual is an enlarged and revised edition of *Tentative Standards of the Hydraulic Institute—Pipe Friction*. It is based not only on the latest information available but also on suggestions by users of the earlier work. Of particular value are numerous examples giving actual mathematical solutions of pipe-friction problems, tables of friction loss for water in feet per 100 feet of pipe up to 84 inches inside diameter and tables of resistance coefficients for valves and fittings that show values in more detail with respect to size and type than heretofore. The book is a complete treatise on the subject with a full list of references of the source material and will serve hydraulic engineers as a guide and college students as a textbook. Published by Hydraulic Institute, 122 E. 42nd Street, New York 17, N.Y. Price: domestic, $1.75; foreign, $1.85.

A List of American Standards, 1955 edition, indexes about 1500 American Standards covering many fields including construction, civil engineering, mechanical, electrical, mining and metallurgy, petroleum products, photography, motion pictures and safety. There is a separate section on consumer goods.

Circle 21E on reply card

A new line of cartridge air valves with built-in speed control is described in a leaflet available from Carter Controls, Inc. The three basic types—solenoid-, palm-poppet and lever-poppet operated—are shown diagrammatically, and applications, construction, parts and mounting brackets are listed.

Circle 22E on reply card

In a 32-page picture-and-text book, Standard Pressed Steel Company, Box 811, Jenkintown, Pa., discusses its recently completed million-dollar plating plant which, because it exceeds the firm's requirements, has been opened to precision-plating jobs of a wide variety from outside firms anywhere in the United States. Entitled *Precision Plating, a Product and a Service*, requests for the publication should be written on company letterheads.

J. N. Fauver Company has released a 24-page catalogue, No. 55, containing descriptions and specifications, along with engineering data, on its industrial hose assemblies, couplings, stems, swivels and accessories.

Circle 23E on reply card

Powermatic air-hydraulic pumps designed for small-volume high-pressure industrial service are described in a 4-page folder offered by Powermatic Sales Company. Representative uses are listed and illustrated.

Circle 24E on reply card

Operation Rehabilitation is the title of a bulletin published by Maintenance Engineering Corporation to acquaint industry with a service it is prepared to render. It involves inspection of disabled equipment, analysis of failure and restoration on location wherever possible.

Circle 25E on reply card

Alloy Steel Pays Off is the title of a 200-page handbook offered by Climax Molybdenum Company to technical, administrative and equipment purchasing and maintenance personnel. It points out the economic advantages of fabricating with alloy steels and cites more than 60 case histories to bear out its contentions. Requests for copies should be addressed directly to the company at 500 Fifth Avenue, New York 36, N. Y.

In an 8-page folder Delta Power Tool Division of Rockwell Manufacturing Company has announced its entry into a new field, the manufacture of a 11-inch metal-cutting lathe that is designed to fill the need for a low-cost quality lathe for machine shops and toolrooms. The features of the lathe, which is available in ten basic models, are explained by cutaway illustrations and line drawings.

Circle 26E on reply card

Powerflo pumps, circulating systems and equipment manufactured by Gray Company, Inc., to spray or extrude liquids, semiliquids and semisolids such as paints, waterproofing. insulation, adhesives and lubricants are described in Catalogue 452, which also contains ideas on how to reduce costs and increase production.

Circle 27E on reply card

Heli-Coil Corporation has announced Bulletin No. 724 describing its new "Shop-pack" which contains wire-thread inserts, a tap and an inserting tool for thread repairs. Illustrations show the three steps involved in making permanent thread repairs in steel, cast iron, aluminum, magnesium, copper, plastics and wood.

Circle 28E on reply card

Ingersoll-Rand Company will mail upon request a new 24-page bulletin covering its full line of close-coupled Motorpumps of ¼ to 75 hp delivering from 5 to 2800 gpm. Each class is explained and illustrated, together with a heavy-duty 75-hp unit that has been added to the line. Also shown are self-priming and jet pumps and how standard models can be modified to provide hundreds of combinations to meet specific requirements. Six pages are given over to tables of dimensions, weights, performances, mountings and pipe friction, as well as to

pumping problems and their solutions. The booklet, Form 7093-E, is designed to help users select the correct size and model to serve individual needs.

Circle 29E on reply card

Heavy duty d-c contactors and control relays for steel-mill and similar heavy-industry applications are the subject of Bulletin 14B8171A released by Allis-Chalmers Manufacturing Company.

Circle 30E on reply card

Physical and chemical properties and typical applications of Nicrobraz stainless-steel brazing alloy are described in a 4-page catalogue prepared by Stainless Processing Division of Wall Colmonoy Corporation.

Circle 31E on reply card

The Swartwout Company has published a condensed catalogue on its Autronic Control System, a miniature all-electronic unit for process and power instrumentation. The functions of each of the different models are described briefly.

Circle 32E on reply card

The characteristics and properties of Nylaflow, a flexible nylon tubing for the transmission of compressed air, hydraulic fluids, coolant, fuel, oil, etc., are described in a bulletin issued by The Polymer Corporation. The company's Product Development Department is ready to help solve unusual industrial problems of this nature.

Circle 33E on reply card

Bulletin No. 520 has been prepared by Sarco Company, Inc., to help users of compressed air maintain the capacity of their installations. Partly a handbook, it describes the company's cooling controls for compressor jackets, aftercoolers and intercoolers, as well as drain traps, electric thermostats and pressure switches.

Circle 34E on reply card

A Selection Guide to Corrosion-Resistant Cast Alloys, a comprehensive article intended to aid design engineers, is available from the Alloy Casting Institute. Reprinted from the December 1954 issue of *Machine Design*, it was prepared by E.A. Schoefer, executive vice-president of the institute.

Circle 35E on reply card

A new brochure obtainable from Air-Maze Corporation contains engineering, operating and application data on its line of Type PL pipe-line filters for the removal of water, oil, dirt and scale from compressed air or gas lines. Included is a table for the quick computation of the correct-size filter for any given installation.

Circle 36E on reply card

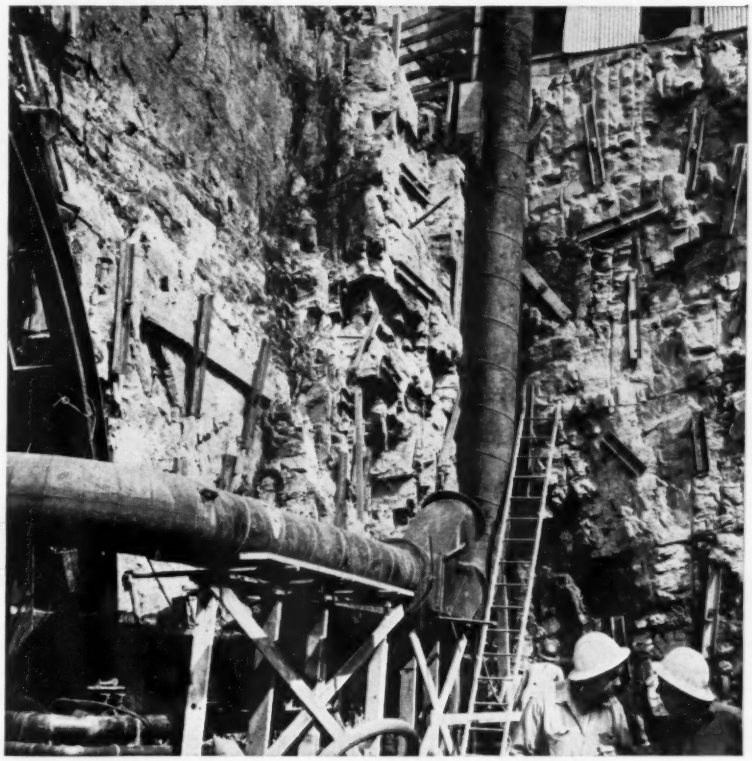
Basic Refractories, Inc., has published a booklet entitled *Operating Practices with the Basic-Lined Cupola* which gives a detailed description of this relatively new foundry practice and explains the mechanics of basic slag systems. Installation and maintenance of linings are discussed, as well as certain operating difficulties.

Circle 37E on reply card

A 68-page catalogue, GEC-1260A, on general-purpose control devices such as motor starters, contactors, relays, solenoids, switches and push buttons has been announced by General Electric Company. Included is a special section correlating, by horsepower, components for each type of motor-control application, as well as data comparing the merits of manual and magnetic control and across the-line and reduced-voltage control.

Circle 38E on reply card

AIR FUNNEL FOR TUNNEL



For those vital ventilating lines in underground construction, contractors know they can depend on Naylor Spiralweld pipe. Along with light weight for easier handling and installation, Naylor pipe offers a structure with the collapse strength necessary for push-pull ventilation. With Naylor one-piece Wedge-Lock couplings to speed connections, you have a combination that's made to order for construction jobs like this. Sizes: 4″ to 30″ in diameter. Thickness from 14 to 7 gauge.

Write for Bulletin No. 507.

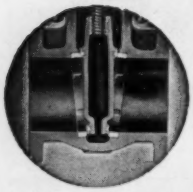
NAYLOR PIPE

NAYLOR PIPE COMPANY

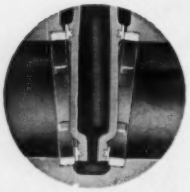
1245 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York

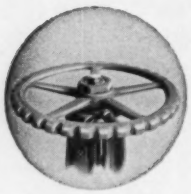
Circle 20A on reply card



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.



Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

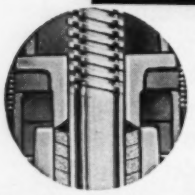
WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



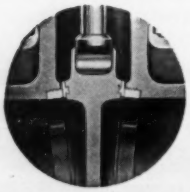
Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

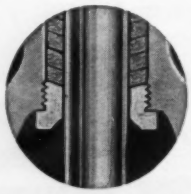
valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

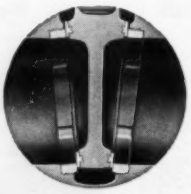
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



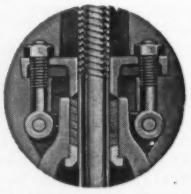
T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.



Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

Circle 21A on reply card

Air hose with tube and cover of NEOPRENE stands up to severe service in mines

Air hose supplying a drill takes a beating from the moment it enters the mine. It's dragged over jagged rubble as the operator drills for a dynamite shot . . . yanked around sharp corners on the way to the next shot. Rough going for *any* hose not constructed with rugged neoprene, Du Pont's chemical rubber.

TOUGH HOSE COVERS of neoprene stand up to pulling and flexing without cracking . . . won't chip or tear on rough surfaces. And neoprene won't spread flame, particularly important in mine operations.

STURDY TUBES of neoprene help avoid slow-ups on the job. They stay firm, flexible . . . resist hot oil in the line. Result: no particles crumble off to clog vital tool parts. Work progresses *on schedule.*

Wherever air hose is used, neoprene gives the braid or fabric reinforcement maximum protection. For work outside the mine, neoprene's resistance to sunlight, heat and weathering gives hose a long lease on life.

DU PONT SUPPLIES neoprene to hose manufacturers who use it in their top-quality lines. Ask your supplier about all kinds of hose with tube and cover of neoprene. He'll be glad to show you how it's built for rugged service.

FREE! THE NEOPRENE NOTEBOOK
Each issue brings you new, unusual applications of neoprene . . . new products . . . interesting articles. Send in this coupon to E. I. du Pont de Nemours & Co. (Inc.), Elastomers Div. CA-6, Wilmington 98, Del.

NEOPRENE
The rubber made by Du Pont since 1932

DU PONT
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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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Elastomers Division CA-6
Wilmington 98, Delaware

*Name*_____ *Position*_____

*Firm*_____

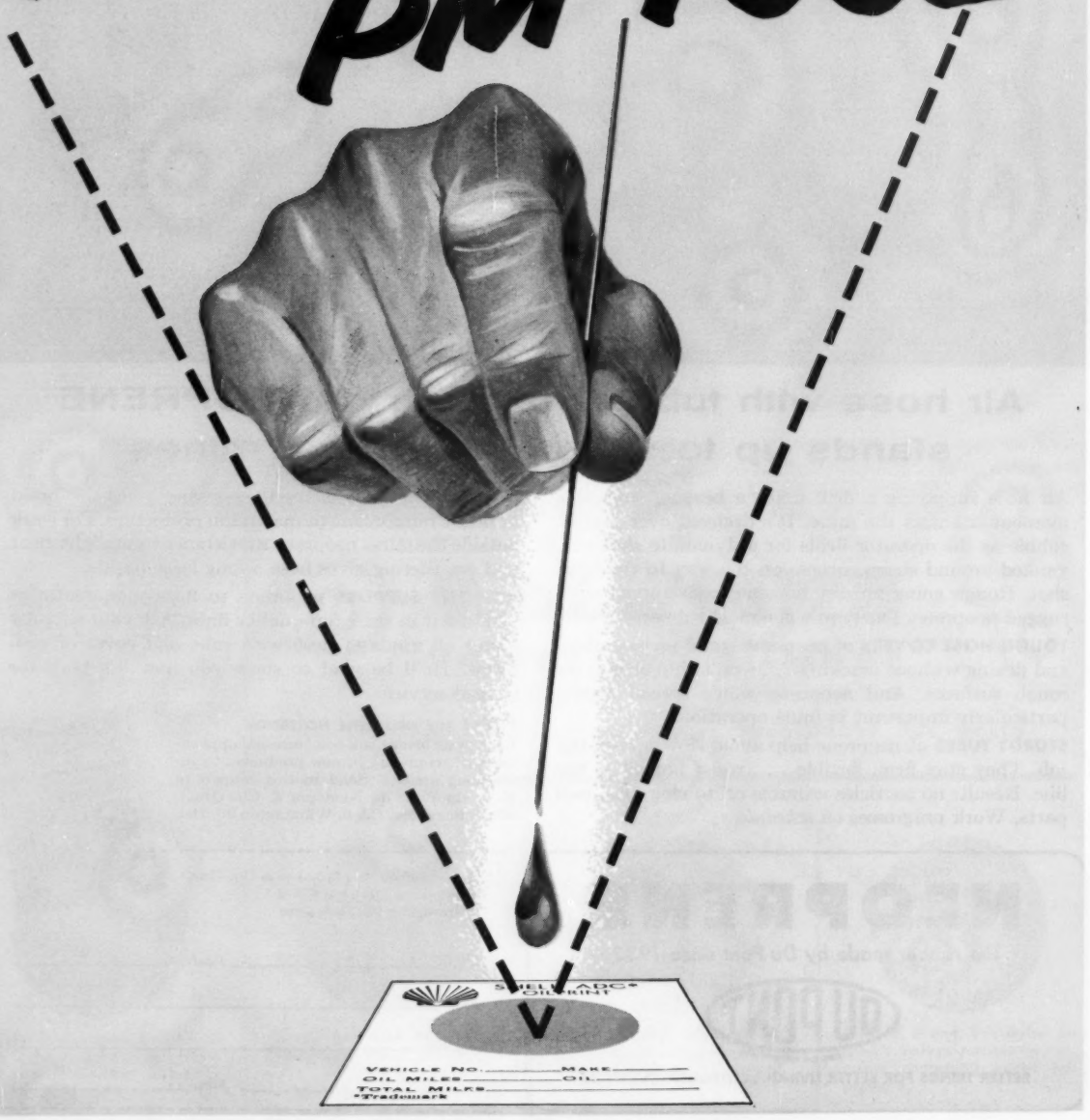
*Address*_____

*City*_____ *State*_____

Circle 22A on reply card

DIESEL AND GASOLINE ENGINE OPERATORS

A NEW PM TOOL



ADC* Oilprint Analysis

CHECKS CRANKCASE OIL IN MINUTES

Shell Research gives you new oil-change yardstick—

Now—operators can test crankcase oil in the short time allotted for refueling and crankcase oil checks. The Shell ADC Oilprint Analysis gives a practical and accurate oil evaluation in minutes.

ADC Oilprint Analysis means big savings when used in your preventive maintenance program . . . gives valuable information on engine and oil conditions. It answers the question "When do I change my oil?" thus eliminating the draining of usable oil and the risk of using oils loaded with contaminants.

See for yourself how the new Shell ADC Oilprint Analysis can save you money in preventive maintenance. Let us show how you can use this new service for your equipment.

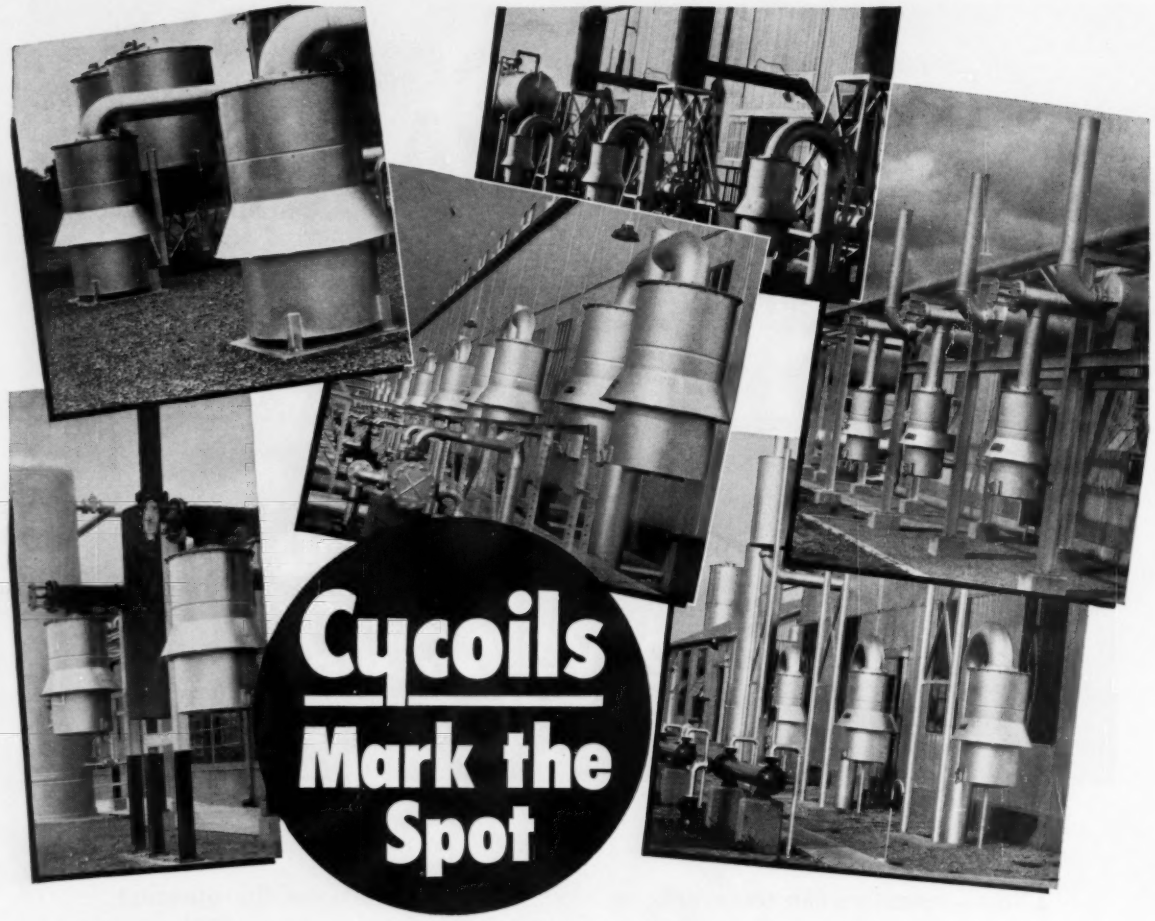
SAVES... Time, Money, Engines, Oil

*Trademark

SHELL OIL COMPANY,

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL



Where Engines and Compressors Enjoy Complete Dust Protection

Such spots are numbered by the hundreds. Nor are all of them confined to the "dust bowl" areas of the nation. Find a cost-minded management that recognizes how dust damage contributes to engine down-time and repairs and you'll find dependable Cycoil Oil Bath Air Cleaners on the job.

What's the secret of Cycoil's industry-wide acceptance? They're designed to fight for every particle of dust. Thorough mixing of oil with the intake air at the start results in over 90% of the dust content being trapped before it even reaches the Cycoil's filter pads. Then comes the final cleaning action of the filter pads for removal of the remaining 10%. Net result—approximately 100% clean air.

Why not get a firsthand report from the folks who really keep a running score on Cycoil performance? Write us today for list of representative users and complete Cycoil data.

AAF **American Air Filter**
COMPANY, INC.

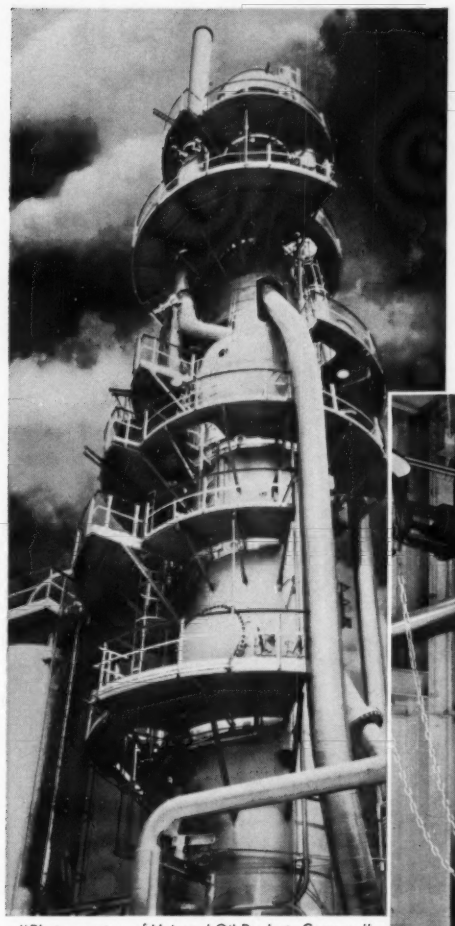
402 Central Avenue, Louisville 8, Kentucky • American Air Filter of Canada, Ltd., Montreal, P. Q.

I-R TURBO-BLOWER

supplies 13,800 cfm for

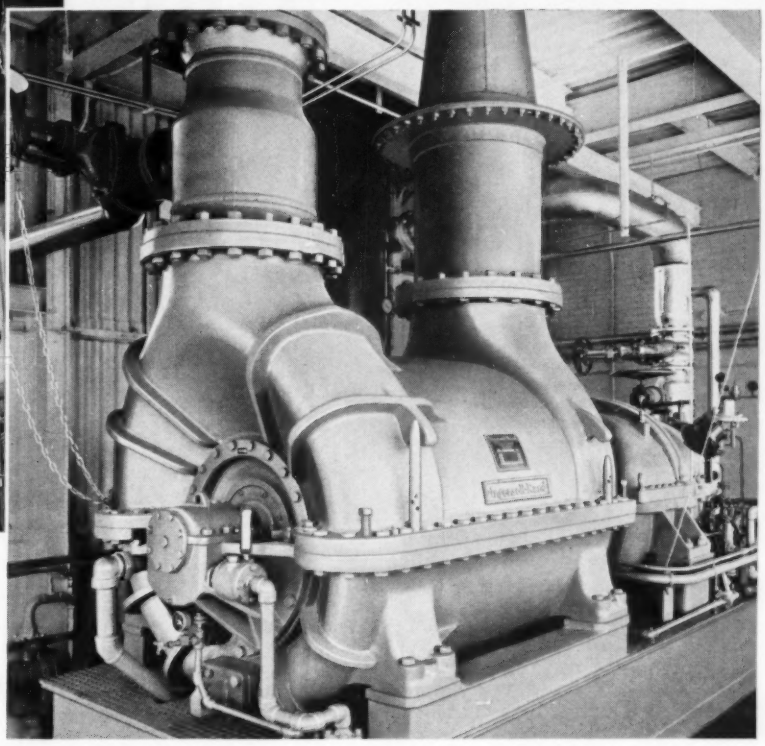
NEW CAT CRACKER

at Premier's Fort Worth Refinery



"Photo, courtesy of Universal Oil Products Company"

Premier's new 3,000 barrel UOP Fluid Catalytic Cracker.



Ingersoll-Rand steam turbine driven Turbo-Blower, rated 13,800 cfm, 46.3 psia discharge.

With the installation of this 3,000 barrel Catalytic Cracking unit, designed and licensed by Universal Oil Products Company, the Premier Oil Refining Company of Texas has completed a multi-million dollar expansion program at the Ft. Worth plant. The new unit permits operating the refinery at its crude oil capacity of 7,500 barrels a day — and provides not only the Fort Worth refinery but Premier's three other Texas refineries with a blending stock having an F-1 leaded octane rating of 98 to 100.

Air for the new Cat Cracker is supplied by the Ingersoll-Rand steam turbine driven Turbo-Blower shown above, which delivers 13,800 cfm at 46.3 psia discharge. Other I-R equipment serving Premier's Fort Worth Refinery includes three 165-hp JVG gas-engine-driven compressors, and a number of I-R centrifugal pumps.

Wherever dependability and economy of operation must go hand-in-hand, it pays to specify Ingersoll-Rand for your process equipment requirements. Call your I-R engineer for complete details.

12-231

Ingersoll-Rand

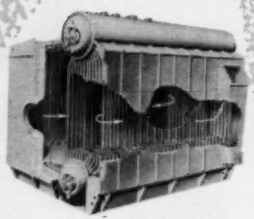
11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

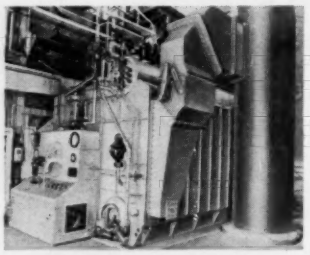
Circle 25A on reply card

now... Combustion's VP Boiler with a

NEW LOOK

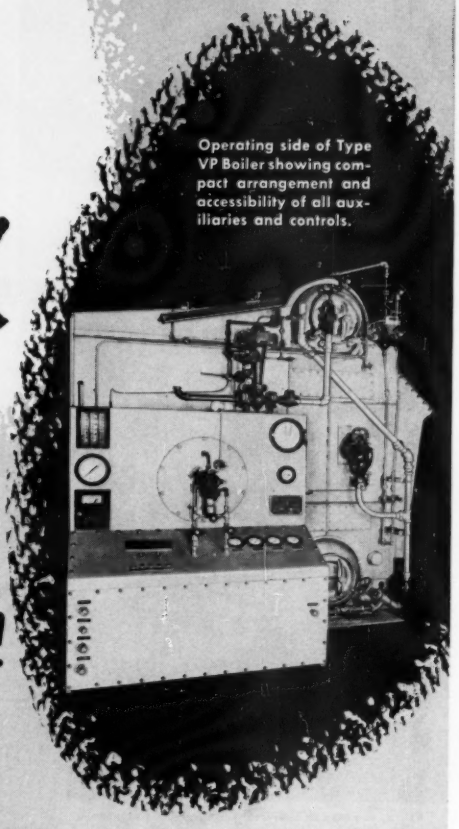


Cutaway view showing arrangement of two-pass VP Boiler.



Industrial installation of VP Boiler in the South. Capacity — 33,000 lb steam per hr; design pressure 250 psi.

gives you more steam per dollar!



Operating side of Type VP Boiler showing compact arrangement and accessibility of all auxiliaries and controls.

THE VP BOILER is available in capacities ranging from about 4,000 to 40,000 lbs of steam per hr, and pressures up to 500 psi.

Combustion's well-known C-E Package Boiler, Type VP, has a *new look* . . . outside and inside!

Outside. The VP's exterior is more streamlined, more compact. The controls and fan are now an integral part of the boiler front. Duct work is simplified. This means better appearance, easier maintenance, better operation.

Inside. Now instead of 2" diameter tubes you'll find 2½" tubes swaged down to 2" at the drums — in all sizes above 15,000 lb per hr capacity. This permits closer spacing of the tube surfaces in the main boiler bank and results in up to 25 per cent more heating surface per tube. It increases mass flow rates, assuring more efficient heat transfer. All this adds to up more steam than from the former VP Boilers of the same size.

All of the existing *extra* features which contributed to the enthusiastic acceptance of the original VP design remain. Briefly summarized they are:

- **More water cooling** per unit of furnace volume than any other boiler of the VP's size and type.
- **Quiet centrifugal fan,** which operates at low speed and with an exceptionally low noise level.
- **Large lower drum,** which facilitates handling wide load swings . . . permits a simple, symmetrical tube arrangement . . . simplifies inspection.
- **Single Burner** assures balanced furnace conditions and air distribution . . . is easier to operate and to maintain . . . simple burner control equipment . . . no air leakage through idle burner . . . change oil gun, when required, in seconds.
- **Simple baffle arrangement,** which means maximum heat transfer rate . . . no dead gas pockets . . . simplified soot blowing.

The *New* VP Boiler not only looks more attractive but it is functionally improved and stands ready to deliver more steam per dollar.

Write, today, for complete information. Ask for new catalog VP-266 (just off the press) which contains specifications and general information on dimensions, space requirements, construction details and controls.

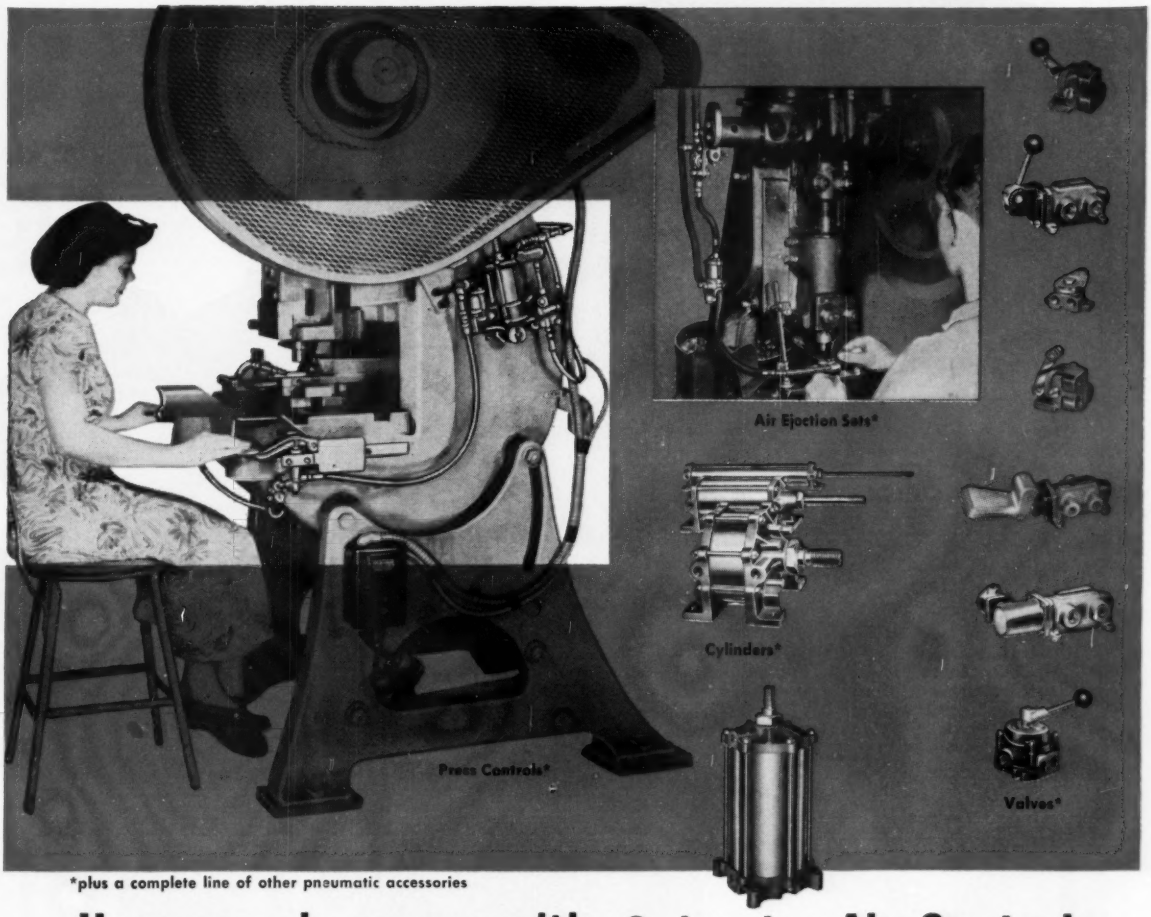
COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

B-8128

Circle 26A on reply card



*plus a complete line of other pneumatic accessories

Harness air power with Schrader Air Control

On many machines, Schrader Control Sets will actually double your production by replacing tedious, time-wasting manual operations with swift, safe, sure movement by air. In other locations, Schrader Valves, Cylinders and other Air Line Accessories lift... lower... pull... push... clamp... clean off. They do many things so easily and quickly that you'll find it hard to believe you did without them before.

Take a look around your plant—keeping in mind where air power could do the job better. Then let us help you develop your ideas into neat, efficient air line hookups that will pay for themselves over and over again the first year. For specific information, write—or, if you prefer, fill out the convenient coupon below.

Schrader
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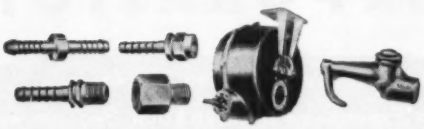
LEADERS IN AIR CONTROL SINCE 1844



The complete Schrader line of pneumatic accessories includes everything you need

A. Schrader's Son
Division of Scovill Manufacturing Company, Incorporated
478 Vanderbilt Avenue, Brooklyn 38, N. Y., Dept. J-6

I am interested in more information on_____

Name_____ Title_____

Company_____

Address_____

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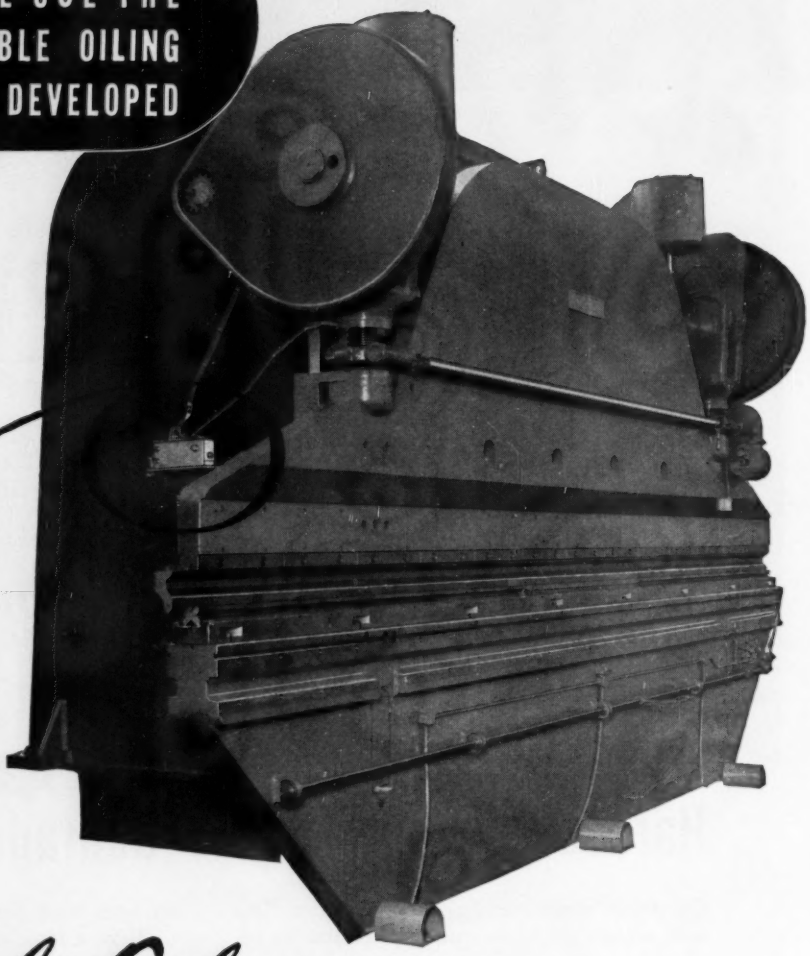
MACHINES OF GREAT PERFORMANCE USE THE MOST DEPENDABLE OILING SYSTEM EVER DEVELOPED



Illustrated is Madison-Kipp Lubricator Model FD installed as original equipment on a ⅜" by 20' Cincinnati Press Brake, manufactured by the Cincinnati Shaper Co., Cincinnati, Ohio.

MADISON-KIPP *fresh Oil* . . . by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy where oil under pressure fed drop by drop can be installed.

MADISON-KIPP CORPORATION

202 Waubesa Street, Madison 10, Wis., U.S.A.

ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

Circle 28A on reply card

Checking the accuracy of fit inside of cylinder. Checker illustrates comparative size of the three 80-inch Koppers Piston Rings required per cylinder. Photo courtesy of S. Morgan Smith Co.

80-inch KOPPERS Piston Rings for McNary Dam Project

In all, 42 such rings will be incorporated in the McNary Dam installation equipment.

S. Morgan Smith Company is installing these tremendous Koppers Piston Rings in Smith-Kaplan blade servomotor cylinders. When fitted with pistons and integrated with the hydro-electric turbine shaft, these units will automatically control the runner blade pitch in proper ratio with the turbine assembly wicket gate openings. These servomotors will operate under a pressure of 350 PSI.

Yes, these are unusually large Koppers Piston Rings. But it is not unusual for Koppers to tackle such piston ring problems. Koppers engineers are so widely experienced and manufacturing facilities are so extensive that Koppers can fill the most difficult of piston ring requirements.

Next time you are concerned with piston rings or sealing rings, whether in replacement or new installations . . . in engines, large or small . . . or if you have a special problem . . . call on Koppers. We are always ready to help you.

Never any obligation, of course. Also, mail coupon for more information.

KOPPERS®

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • Baltimore, Maryland

This Koppers Division also supplies industry with Fast's Couplings, Aeromaster Fans, Koppers Electrostatic Precipitators and Gas Apparatus.

Engineered Products Sold with *Service*

AMERICAN HAMMERED *Industrial Piston Rings*

KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1516 Hamburg Street, Baltimore 3, Md.

Gentlemen: Please send me free 16-page booklet containing full information on Piston Rings.

Name_____

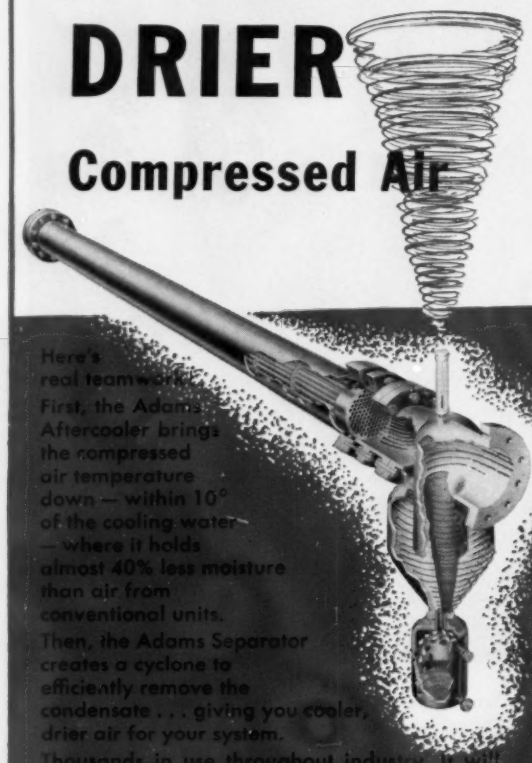
Company_____

Address_____

City_____ Zone_____ State_____

Circle 29A on reply card

We create a CYCLONE to give you DRIER Compressed Air



Here's real teamwork. First, the Adams Aftercooler brings the compressed air temperature down — within 10° of the cooling water — where it holds almost 40% less moisture than air from conventional units. Then, the Adams Separator creates a cyclone to efficiently remove the condensate . . . giving you cooler, drier air for your system. Thousands in use throughout industry. It will pay you to find out all the details. Mail the coupon below today.

R. P. ADAMS CO., Inc.

Buffalo 17, New York

R. P. ADAMS CO., INC. JU-55
209 East Park Drive
Buffalo 17, N. Y.

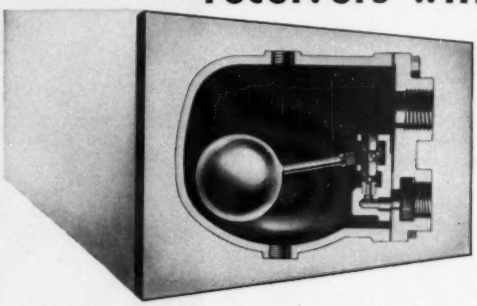
Please send my FREE copy of Bulletin # 711 on Adams Cyclone Separators and Aftercoolers.

Name ..... Firm .....

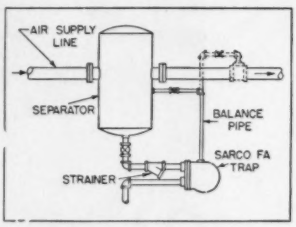
Street ..... City ..... State .....

Circle 30A on reply card

Drain compressed air receivers with



SARCO FA DRAIN TRAPS



Type FA Trap draining separator.

. . . also your intercoolers, aftercoolers and separators. These traps automatically release condensate as it forms . . . without the waste of air that occurs when blowdown valves are used. New technical bulletin No. 5-CA offers many suggestions as to how you can increase the EFFECTIVE capacities of your air compressors. Write today for your free copy. No obligation . . . of course.

513

sarco COMPANY, INC.
Represented in Principal Cities
Empire State Building, New York 1, N. Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

Circle 31A on reply card

NO AIR LEAKS UNDER PRESSURE (or vacuum)

with
HILLS-McCANNA
"cushion closure" action

Here's the valve with the cushioned, leak tight closure that actually *accommodates* itself to surface irregularities, scale or foreign material. Suitable for pressures to 150 psi, temperatures to 170° F. Lever, handwheel or power operated, all working parts isolated from flow. Design eliminates packing. Write for bulletin. HILLS-McCANNA CO. 2361 W. Nelson, Chicago 18, Ill.

HILLS-McCANNA

saunders patent diaphragm valves

Also manufacturers of
Chemical Proportioning Pumps • Force-Feed Lubricators
Magnesium Alloy Sand Castings

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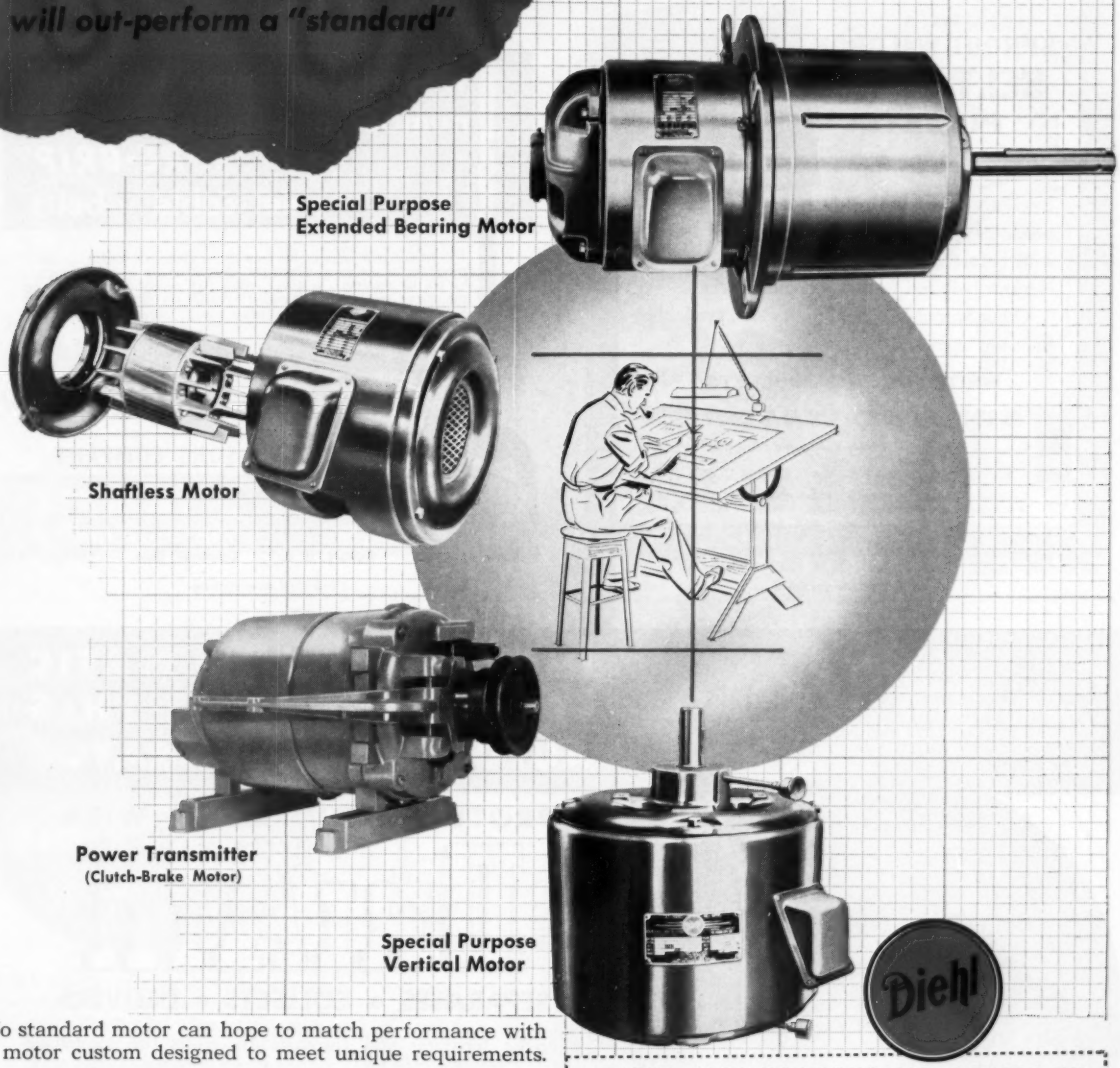
a motor designed for its job

will out-perform a "standard"



No standard motor can hope to match performance with a motor custom designed to meet unique requirements.

That's why Diehl lays so much emphasis on custom construction . . . why, through the years, it has geared its abilities and its facilities, its design, engineering and manufacturing functions for maximum cooperation with its customers . . . whatever the application.

DIEHL custom-tailored motors can:

Cut costs • Save space • Reduce weight • Improve safety
Simplify design • Speed production • Improve appearance

When you want a fast, thorough answer to an unusual motor problem it will pay you to consult Diehl. Name your conditions . . . Diehl will design and build to match.

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Please send me the following bulletins:
☐ New Type "D" Motor Bulletin No. CA-3304
☐ Consolidated Catalog & Price List No. CA-3310

Name_____
Company_____
Street_____
City_____ State_____

INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

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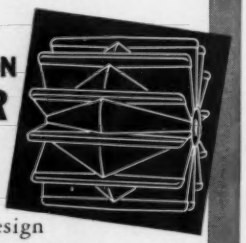
Increase conveyor belt life from
50% to 400%

WITH SPROUT-WALDRON BELT-SAVER PULLEYS



Exclusive cone-wing design produces amazing savings by casting out rough stuff before it can lodge between conveyor or elevator belt and pulley and cause wear.

Other Sprout-Waldron pulleys are available in many types and sizes.

WRITE FOR FREE BOOKLETS!

SPROUT-WALDRON

The Best in Milling Equipment Since 1866

86 LOGAN ST. • MUNCY, PA.

385 *Equipment for* SIZE REDUCTION • MIXING & BLENDING • BULK MATERIALS HANDLING • PELLETING & CUBING • PRODUCT CLASSIFICATION

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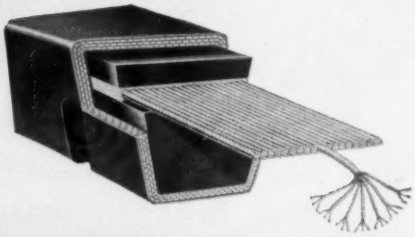

where clearances limit the number of v-belts
specify ***"SURE-GRIP"***
steel cable v-belts

The number of grooves on the face of the sheave, of course, is determined by the number of belts to be used, which, in turn is determined by the HP required. In drives where clearances limit the width of the sheave face, fewer belts must be used, yet be able to withstand the same loads and speeds. Here's where "Sure-Grip" steel cable V-Belts come in.

These belts have higher HP rating due to continuous steel cables that provide super strength, practically zero stretch. Strength member lies in a single plane thus insuring long flex life. Available in A, B, C and D cross sections for medium center, heavy duty drives. For further information write for Bulletin 394.

Woods

T. B. WOOD'S SONS COMPANY

CHAMBERSBURG, PA.

Cambridge, Mass., Newark, N. J., Cleveland, Ohio, Dallas, Texas

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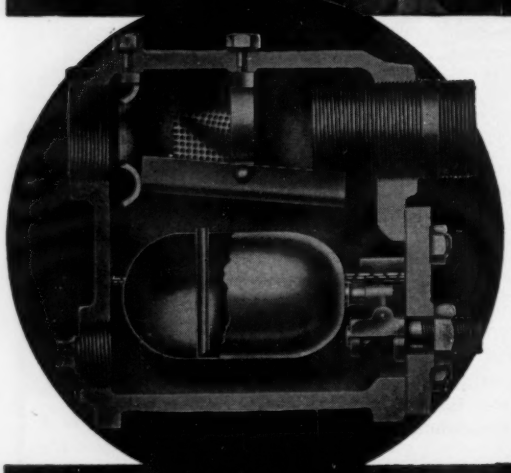
DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

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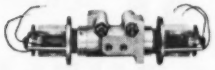
FOR AUTOMATIC CIRCUIT-CONTROL

AIRMATIC VALVES

To meet the increasing demand for fully automatic or semi-automatic operations . . . eliminate the need for manual control. Airmatic Valves perform efficiently . . . maintain greater operating speeds. What's more, they are simple and compact in design—assure best arrangement.

A complete line of 2-way, 3-way and 4-way valves available for high-pressure or low-pressure installations.

Three-Way Valve



Solenoid Valves

Cylinders

Write today for complete details about Airmatic Products

Attractive O. E. M. and Quantity Discounts

Delivery from Stock —Immediate

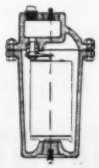
AIRMATIC VALVE INC.

7317 Associate St. Cleveland, Ohio

Circle 37A on reply card

No Moisture Removal System is Complete . . .

without Economical Armstrong Air Traps



KEEP your expensive moisture removal equipment at top efficiency — automatically drain these vital units of the moisture they collect with low cost Armstrong Air Traps. Armstrong traps on separators, aftercoolers, etc., save you air, time and labor, eliminate human failure.

Ruggedly built, these units are available in three types, ball float, snap action or inverted bucket models to give you best service for a given condition.

Bulletin No. 289 gives the details.

Local stocks mean quick delivery. Act today.

ARMSTRONG MACHINE WORKS

885 Maple St. • Three Rivers, Michigan

ARMSTRONG *Air* TRAPS

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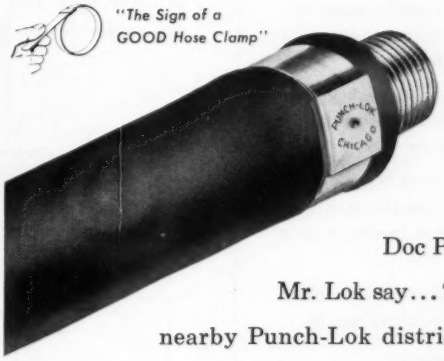
Charm your hose

with PUNCH-LOK

Hose Clamps

"The Sign of a GOOD Hose Clamp"



Doc Punch and Mr. Lok say... "See your nearby Punch-Lok distributor"— or write direct for product and price information.

PUNCH-LOK *Company*

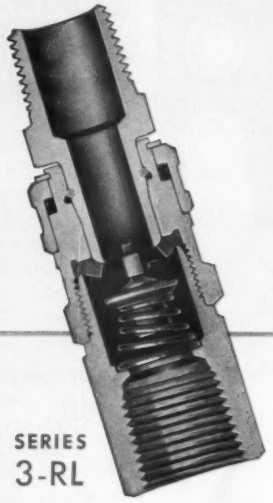
5645

Dept. H. 321 North Justine Street, Chicago 7, Ill.

Circle 39A on reply card

Everything You Want

in a Quick-Connective Pneumatic Coupling



HANSEN SERIES 3-RL

RING-LOCK COUPLING

Compactly designed, the Hansen Series 3-RL Coupling *effectively* handles far more volume than any coupling of equal dimensions. On any job requiring ¾" to ⅛" connections—from the air line to the air tool—this single size Hansen Ring-Lock Coupling—with completely interchangeable Sockets and Plugs—does it all—makes it easy to keep stock of parts in balance—holds inventories to a minimum.

To connect the Series 3-RL Coupling, you merely push the Plug into the Socket. To disconnect, just turn the sleeve. When Coupling is connected, a locking ring in Socket enters groove in Plug, provides positive lock and insures tight fit. Sockets with aluminum bodies are available for use with small hand-operated air tools.

- Smaller.
- Lighter.
- Effectively handles more volume than any other coupling of equal dimensions.
- Handles any job with fittings from ¾" to ⅛", from the air line to the air tool.
- All Series 3-RL Sockets and Plugs are interchangeable—reduces stock inventory to a minimum.
- One-way shut-off—for pneumatic service applications.
- Positive locking.
- Equipped with automatic sleeve lock.

Write for Descriptive Literature

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

AIRengineering at work
REPORT No. 4150.25

Cuts 60 Second ***Metal Drilling Job*** *to 15 Seconds . . .* ***with Air Punching Tool***

A sub-contractor for a large auto manufacturer formerly used two men, an electric drill and a drilling jig to drill two 1/4" holes in rear auto fenders.

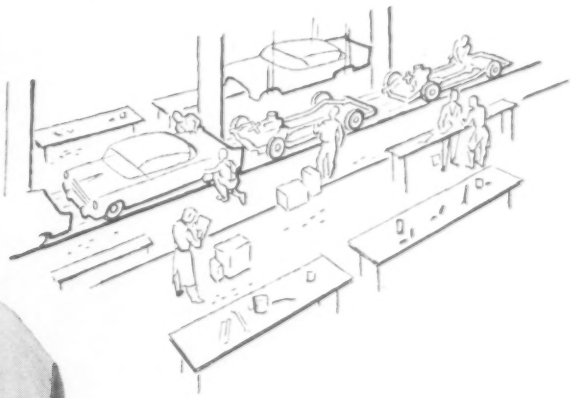
This method required a whole minute and failed to provide uniform results. In addition, paint damage and broken drills caused excess time loss.

AIRengineering by Ingersoll-Rand solved the problem fast. A size AR130 Air Buck Riveter was equipped with special yoke, punches and stripping mechanisms. The holes are now punched four times faster, with closer tolerances and only *one* man is required instead of two.

If you are in a position to encourage cost-savings in your plant, you should see I-R's confidential manual reports on "AIRengineering at Work". Write on your company letterhead and we'll arrange for you to see it soon.

AIRengineering Manual
Over 100 interesting and helpful case history applications of AIRengineering at work.

Ingersoll-Rand
11 Broadway, New York 4, N.Y.



Air Buck Riveter
Punching two 1/4" holes in rear auto fender.

8-257

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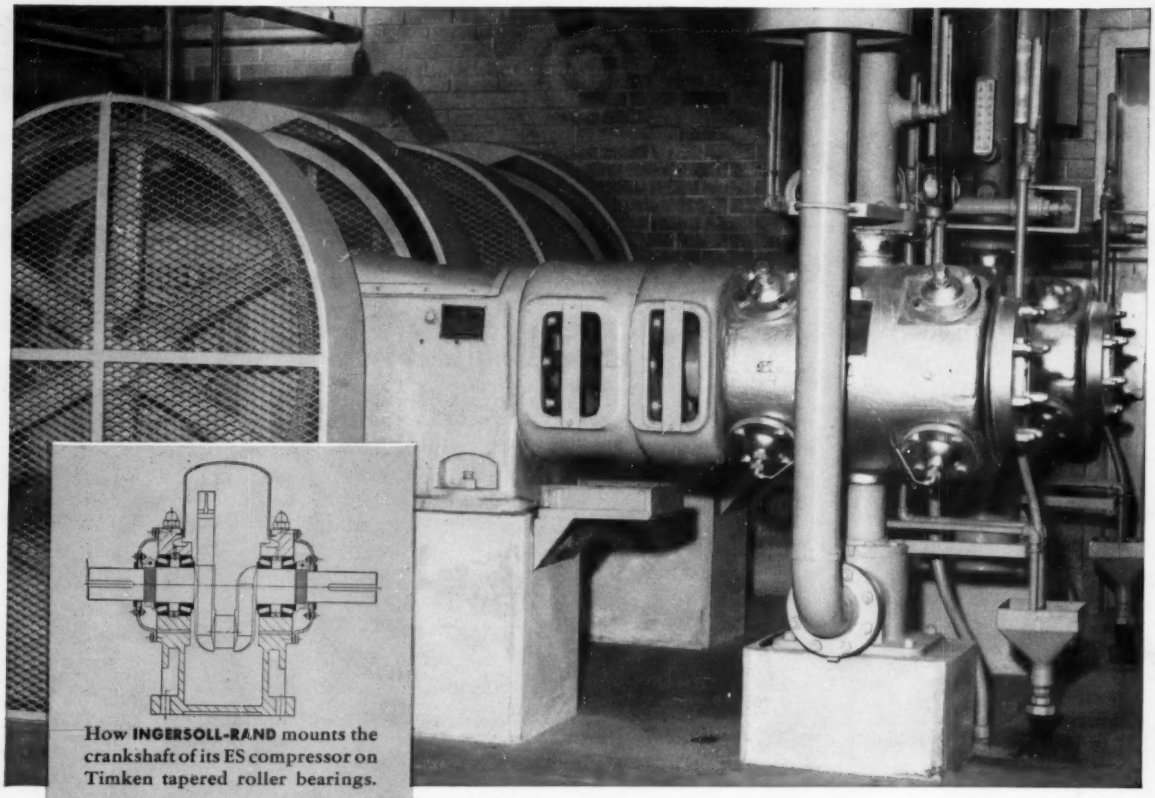

How **INGERSOLL-RAND** mounts the crankshaft of its ES compressor on Timken tapered roller bearings.

Supplies air for instruments, TIMKEN® bearings supply dependability

A STEADY supply of oil-free instrument air is assured by two of these Ingersoll-Rand ES compressors. One big reason is the Timken® tapered roller bearings on the crankshaft that prevent costly breakdowns and maintenance delays.

Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. The crankshaft is held in positive alignment. Wear on moving parts is minimized. And Timken bearings keep housings and crankshaft concentric, making closures more effective. Lubricant stays in; dirt stays out, further reducing maintenance.

There's less power loss in the compressor, because Timken bearings make friction negligible. They're designed to give true rolling motion and precision manufactured to live up to their design.

One big reason Timken bearings give longer life is the steel they're made of—Timken fine alloy steel. We make our own to get the quality of steel to meet our exacting specifications. No other U. S. bearing manufacturer has this extra quality control.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in the machines you build or buy. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →▯← LOADS OR ANY COMBINATION →◎←

WE MAKE OUR OWN STEEL

The special grade alloy steel which gives Timken bearings their strength and resistance to wear is made in our own steel mills.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

Circle 42A on reply card